

Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

A56.9
R31
Cof. 2

James L. Jones
p. 12 #33



4471 RCR/2003/FB - SLEO/DO

ABSTRACTS

of recent published material on
Soil and Water Conservation

Number 36

ARS 41-75-12

Agricultural Research Service

UNITED STATES DEPARTMENT OF AGRICULTURE —

The "ABSTRACTS of recent published material on Soil and Water Conservation" are issued at irregular intervals. Their purpose is to bring together a summary of current published information about soil and water conservation work. Reprints of abstracted articles are generally not available in the Soil and Water Conservation Research Division. Request for reprints should be sent to the authors or institutions, addresses are appended.

The classification of articles follows the table of contents used for the "Soil and Water Conservation Research Needs" of the Soil Conservation Service. Abstracted articles are not editorialized, and the language of the author is used wherever possible. In foreign articles, the units of measure are converted to usual American units. Tables are included where they help to present the information. When the entire number of a publication is devoted to reviewing one subject then the entire publication is abstracted as one article giving title and authors of each paper included in the publication. Abbreviations of journals and addresses follow U.S.D.A. Misc. Pub. 765, July 1958.

This is the 36th of the publications issued by the SCS or ARS under this title. The first 15 issues and number 17, 24, and 25 are out of print.

Those available for distribution are:

(16)	ARS-41-35	Aug.	1959
(18)	ARS-41-39	Oct.	1960
(19)	ARS-41-45	Apr.	1961*
(20)	ARS-41-46	May	1961*
(21)	ARS-41-50	Aug.	1961
(22)	ARS-41-58	May	1962
(23)	ARS-41-67	Jan.	1963
(26)	ARS-41-75-2	Nov.	1963
(27)	ARS-41-75-3	Mar.	1964
(28)	ARS-41-75-4	Apr.	1964
(29)	ARS-41-75-5	July	1964
(30)	ARS-41-75-6	Oct.	1964
(31)	ARS-41-75-7	Feb.	1965
(32)	ARS-41-75-8	Apr.	1965
(33)	ARS-41-75-9	Apr.	1965
(34)	ARS-41-75-10	May	1965
(35)	ARS-41-75-11	June	1965

* Reserved for libraries and institutions.

Soil Conservation Service personnel should address requests for additional copies of ABSTRACTS to the appropriate State Conservationist.

Authors of articles and reports in the field of soil and water conservation are urged to supply abstracts, reprints, or copies to the abstractor:

Charles B. Crook, Soil and Water Conservation Research Division, Agricultural Research Service, U.S. Department of Agriculture, Plant Industry Station, Beltsville, Maryland, 20705

CONTENTS

	Page Number	Index Number
WATERSHED ENGINEERING		
Hydrology	1-3	1-13
Geology	4	14
Engineering design	4-5	15-18
Snow surveys	5	19
Ground water recharge	6	20
 WATER MANAGEMENT		
Irrigation	6-11	21-28
Drainage.	11-14	29-39 ✓
Storage and conveyance.	15-16	40-42
 BASIC SOIL SCIENCE		
Soil physics.	16-19	43-53
Soil chemistry and mineralogy	20-29	54-79
Soil biology.	29-33	80-88
Soil-plant-animal relationships	34-41	89-110
Soil classification	42-47	111-119
 EROSION CONTROL		
Erosion equation.	47-48	120-121
Wind and water erosion	48-50	122-135
Terracing	50-51	136-137
Critical areas.	51	
 SOIL MANAGEMENT		
Cropping practices.	51-52	138-141
Crop residue management	53	-
Tillage	53-54	142-144
Fertility requirements for conservation farming .	54-64	145-168
Salinity and alkali problems.	64-68	169-174
Cover crops and green manure crops.	68	175
Climatic influences	68-72	176-183
Mulching.	72	184
 PLANT MANAGEMENT		
Pasture and haylands.	72-76	185-191
Rangelands.	76-77	192-193
Plant materials	77-78	194-195
Woodlands	78-83	196-207
Windbreaks.	83	208
Management of coffee plantations.	83-84	209
Fruit and nut crops	84-86	210-215
Field crops	86-94	216-232
Vegetable crops	94-95	233-234

	Page Number	Index Number
ECONOMIC AND SOCIAL ASPECTS OF SOIL CONSERVATION		
Costs and returns	95-100	235-241
Institutional, educational, and social factors affecting conservation application.	100-102	242-245
BIOLOGY		
Fish.	102-103	246-247
Upland wildlife	103-108	248-258
Wetland wildlife	108-111	259-264
SUPPLEMENT		
Problems indirectly affecting the application of soil and water conservation practices	111-114	265-273
Radioactive fallout	114-117	274-298

Mention of a proprietary product in this publication does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture and does not imply its approval by the department to the exclusion of other products that may also be suitable.

Caution: If pesticides are handled or applied improperly, or if unused parts are disposed of improperly, they may be injurious to humans, domestic animals, desirable plants, pollinating insects, fish or other wildlife, and may contaminate water supplies. Use pesticides only when needed and handle them with care. Follow the directions and heed all precautions on the container label.

WATERSHED ENGINEERING

Watershed Development

SEE 8, 11, 177, 200.

Hydrology

SEE ALSO 15, 19, 22, 40, 41, 42, 45, 46, 134, 177.

1. Volk, G., Ed. PROCEEDINGS OF WATER RESOURCES SEMINAR OCTOBER 3, 1963, WOOSTER, OHIO. Ohio Agr. Expt. Sta. Spec. Rpt. Ser. 2. 1963.

The following list gives the name of author, title of article, and the address of author for each paper presented at the seminar.

2. Kottman, R. M. OBJECTIVES OF THE SEMINAR. Ohio Agr. Expt. Sta., Wooster, Ohio.
3. Youngquist, C. V. STATUS OF WATER RESOURCES IN OHIO. Div. Water, Ohio Dept. Natural Resources.
4. Alban, K., Shambaugh, G. O., and Wilson, E. WATER QUALITY AS AFFECTED BY AGRICULTURAL CHEMICALS AND OTHER CONTAMINANTS — PANEL DISCUSSION. Ohio Agr. Expt. Sta., Wooster, Ohio.
5. Mederski, H. J. RESEARCH NEEDS FOR IMPROVING THE EFFICIENCY OF WATER USE BY PLANTS. Ohio Agr. Expt. Sta., Wooster, Ohio.
6. Harrold, L. WHAT WE DON'T KNOW IN WATERSHED HYDROLOGY. SWCRD, ARS, USDA, Coshocton, Ohio, 43812
7. Beattie, J. M. SUMMARY. Ohio Agr. Expt. Sta., Wooster, Ohio.
8. Blackmarr, W. H., and White, D. P. A 22-YEAR PROGRESS REPORT OF HYDROLOGIC STUDIES ON THE ROSE LAKE WOODED WATERSHED IN SOUTHERN MICHIGAN. Mich. Agr. Expt. Sta. Q. B. 46(4): 542-560. 1964.

The hydrologic effects of clearcutting an oak-hickory forest on an experimental watershed in southern Michigan were described. Climatic, soil, vegetation and run-off data were collected for a period of 11 years. The area was clearcut removing all trees over 5 inches in diameter; changes during the next 11 seasons were described.

No reduction in infiltration occurred after clearcutting. Erosion and surface run-off showed no increase following removal of the forest overstory. Evapotranspiration was temporarily reduced. The 10 square feet of basal area left after logging increased to 50 square feet with a temporary major shift in species distribution from oak-hickory to a predominantly black cherry (Prunus serotina) stand with much smaller amounts of oak and hickory.

Mich. State U., Agr. Expt. Sta., East Lansing, Mich.

9. Rzhanitsyn, N. A. MORPHOLOGICAL AND HYDROLOGICAL REGULARITIES OF THE STRUCTURE OF THE RIVER NET. U.S. Dept. Agr., Agr. Res. Serv., Soil and Water Conserv. Res. Div. Unnumbered translated reprint, 380 pp. 1960 (reprint 1964).

Average characteristics of river channels were given and the regularities of their changes along the length of the river and at confluences where two smaller rivers

form a new, larger one were outlined. The individual characteristics of rivers which determine the relief of the channel were examined. The possibility of applying the obtained relationships in the solution of problems in modeling the channel process and in calculating the longitudinal profiles of rivers were shown by examples.

This book was written for hydrologic engineers and technicians and was translated from Russian by D. B. Krimgold.

Reprints, L. L. Kelly, SWCRD, ARS, USDA, Beltsville, Md., 20705

10. Boelter, D. H. WATER STORAGE CHARACTERISTICS OF SEVERAL PEATS in situ. Soil Sci. Soc. Amer. Proc. 28(3): 433-435. 1964.

Water storage characteristics of the various horizons in a northern Minnesota bog were found to vary considerably with peat type. Surface horizons of sphagnum moss peat contain 0.020 g. per cc. of dry material and 95 to nearly 100 percent water by volume at saturation. Its total porosity consisted primarily of large pores which released 0.80 cc. of water per cc. between saturation and 0.1 bar suction.

Decomposed and herbaceous peats from horizons below 25 cm. had water-holding properties strikingly different from those of the moss peats. These materials had bulk densities of 0.24 and 0.14 g. per cc., respectively, and they contained between 80 and 90 percent water by volume at saturation. Their porosity, though high, consisted primarily of many small pores which are not easily drained at low suctions. They retained 65 to 75 percent water by volume at 0.1-bar suction.

A specific change in water table elevation in the horizons containing loose, porous, undecomposed moss peat would involve a great deal more water than the same change in horizons on more dense decomposed and herbaceous peats. Thus, the hydrologic role of any bog or bog area in a watershed will depend on the type of peat found in the organic soil profile.

Lake State Forest Expt. Sta., FS, USDA, St. Paul, Minn.

11. Betson, R. P. WHAT IS WATERSHED RUNOFF? J. Geophysical Res. 69(8): 1541-1552. 1964.

A nonlinear mathematical model, starting with the integral of an infiltration capacity function, was developed to analytically equate the difference between rainfall and runoff to hydrologic variables. Only the three independent variables — storm rainfall, duration, and soil moisture was used, and an equation was evolved in which the identity of the coefficients was kept intact and unusually good statistical control was maintained. The coefficients of the equation appear to be stable over a range of watershed sizes and conditions. The equation strongly indicated that runoff usually originates from a small, but relatively consistent, part of the watershed. The function can be manipulated to show a "function of apparent watershed infiltration capacity." This function characterizes the infiltration capacity of that portion contributing to runoff, on the average, and should prove to be a useful infiltration capacity index with which watersheds can be compared.

The equation itself provides insight into why in situ measurements of infiltration capacity seldom agree with the capacity determined from rainfall-runoff data. It also indicates why storm runoff frequently is not linear with respect to causative factors.

TVA, Knoxville, Tenn.

12. Kincaid, D. R., Gardner, J. L., and Schreiber, H. A. SOIL AND VEGETATION PARAMETERS AFFECTING INFILTRATION UNDER SEMIARID CONDITIONS. Internat'l. Assoc. Sci. Hydrol. 65: 440-453. 1963.

On subwatersheds of the Walnut Gulch Experimental Watershed measurements of precipitation and runoff showed extreme variation in the rainfall-runoff relation. This variation was attributed to irregularity of amount, intensity, and distribution of the precipitation and to unmeasured differences among the subwatersheds.

To ascertain effects of soil on infiltration, rain gages and Bouyoucos moisture blocks were installed on a 4.5-acre, grass-covered drainage area of igneous soil and on a 3.0-acre drainage area of calcareous soil supporting a shrub cover. Soil in the grassland area showed greater and more abrupt responses to rainfall at the 6- and 18-inch depths. Moisture depletion at the 6-inch depth was more rapid in the grassland area, indicating more rapid evaporation or more complete root permeation of the upper soil or a combination of these two conditions. Moisture withdrawal from the 18-inch depth was about the same on the two areas. Pits dug through the soil profile showed little root penetration below the 20-inch depth on either area.

To determine the relation of infiltration to different factors in the soil-vegetation complex, infiltrometer tests were made with a Type-F infiltrometer on randomly selected 6 X 12-foot plots. Cumulative short-time infiltration increased with surface gravel. Crown-spread of shrubs appeared to be more closely related to infiltration than any other single parameter of vegetation. The combination of the shrub and half-shrub overstory with ground cover of surface gravel, litter, and grass showed the best observed relation to cumulative short-time infiltration; and a fair curvilinear relation was demonstrated between crown-spread of shrubs and half-shrubs and final infiltration capacity.

Southwest Rangeland Hydro1. Res. Watershed, SWCRD, ARS, USDA, Tucson, Ariz., 85717

13. Sharp, A. L., Bond, J. J., Neuberger, J. W., Kuhlman, A. R., and Lewis, J. K. RUNOFF AS AFFECTED BY INTENSITY OF GRAZING ON RANGELAND. J. Soil and Water Conserv. 19(3): 103-106. 1964.

In studies initiated at the Cottonwood Range Field Station, Cottonwood, S. Dak., in 1963, runoff was measured on ranges that had been subjected to light, moderate, and heavy grazing since 1942. Vegetation on the experimental watersheds also was characterized.

In June 1963, the total quantity of vegetation under heavy grazing was only one-half as great as that under light grazing. There were marked differences in plant composition on the watersheds differentially grazed. Watersheds lightly and moderately grazed contained an abundance of the high-producing midgrasses; those heavily grazed had a cover comprised largely of shortgrasses.

Relatively little difference in total runoff from the lightly, moderately, and heavily grazed watersheds occurred as the result of four runoff-producing storms. However, with three of the four storms, runoff increased markedly with increased grazing pressure. During these three storms, total runoff from heavily grazed area was approximately 1.5 times greater than that from moderately grazed watersheds. Runoff under light grazing was only one-tenth as great as that under heavy grazing. Runoff was less under heavy grazing than under light grazing during the storm of June 15 where more than 8 inches of precipitation was received during the 3-week period between May 25 and June 15.

Collaborator, SWCRD, ARS, USDA, 1697 SW 19th St., West Linn, Oreg.

Geology

SEE ALSO 9, 15, 17, 171.

14. Zaslavsky, D., and Kirkham, D. THE STREAMLINE FUNCTION FOR AXIALLY SYMMETRIC GROUNDWATER MOVEMENT. *Soil Sci. Soc. Amer. Proc.* 28(2): 156-160. 1964.

The equation for the stream function for axially symmetric potential flow of ground water was derived. The equation was illustrated by obtaining the streamlines for flow into an auger hole as used for hydraulic conductivity determination of soil.

Israel Inst. Tech., Haifa, Israel.

Engineering Design

SEE ALSO 9, 11, 14, 22, 46, 47.

15. Kindingstad, E. MATHEMATICAL MODEL FOR TRANSIENT RIVER FLOW. *J. Hydraul. Div.* ASCE 90 (HY 3): 23-38. May 1964.

The mathematical modeling of transient river flow involves the following major problems: (1) It is necessary to describe mathematically the propagation of the water already in the river; and (2) methods must be established for predicting local inflow to the main river stem as a result of rainfall or snow melting. The solution to the first problem was presented.

Mathematical models for flood routing that are in common use today (1964), neglect river dynamics altogether in order to simplify longhand computation. This limitation can be overcome by using a high-speed digital computer to solve the more complete dynamic river problem. The mathematical model presented was based on Bergerson's numerical method for the solution of plane wave phenomena. The author concluded that:

1. Bergerson's method for the solution of plane wave phenomena can be used to advantage in mathematical modeling of open channels and rivers. The model includes dynamic effects (wave motion) storage, and friction effects.
2. The resulting equations were especially well-suited for efficient programming on a digital computer. When a digital computer is used in river forecasting, one can take advantage of the high-computing speed to work with the more sophisticated river model and river forecasts may be made much more frequently. Forecasting errors can be reduced by making use of the latest available information on the river stages.
3. Forecasting accuracy for 24-hr. predictions with the model typically approximates 5 percent during strong river transients, and less when the flow changes slowly.
4. Honeywell 610 computer requirements for model representing a river section 100 miles long: 1-1/2 min. machine time for each 24-hr. prediction run; approximately 850 words memory storage.

Control Systems Analyst, Minneapolis Honeywell Regulator Co., Special Systems Div., Pottstown, Pa.

16. Simmons, W. P. TRANSITIONS FOR CANALS AND CULVERTS. *J. Hydraul. Div.* ASCE 90 (HY 3): 115-153. May 1964.

Results of model studies of variations in open-type inlet and outlet transitions for small canals and culverts were presented. Lower losses and better performance

resulted when closed-conduit sections were added between the pipelines and transitions. Best results were obtained with a 6-diameter-long closed-conduit transition that terminated in a headwall normal to the canal centerline.

Div. Res., U.S. Bureau Reclam., Denver, Colo.

17. Hubbell, D. W., and Sayre, W. W. SAND TRANSPORT STUDIES WITH RADIOACTIVE TRACERS. J. Hydraul. Div. ASCE 90 (HY 3): 39-68. May 1964.

Radioactive tracer techniques provided a feasible means for applying Lagrangian techniques to the observation of sediment transport processes in natural rivers and laboratory flumes. The transport of bed-material particles was described as a sequence of alternating steps and rest periods of random length and duration. The assumption of exponentially and identically distributed incremental step lengths and rest periods led to a longitudinal concentration-distribution function that agreed with experimental results obtained in the North Loup River, Nebr., and in a laboratory flume. Bed-material discharge was computed from a continuity equation in which the velocity was defined by the rate of movement of the mean position of a group of tracer particles, and the area was defined as the average cross-sectional area of the bed through which the tracer particles were distributed.

U.S. Geol. Survey, U.S. Dept. Int., Portland, Oreg.

18. Schimming, B. B., and Kondner, R. L. AUXILIARY POTENTIAL FUNCTION FOR SEEPAGE. J. Irrig. and Drain. Div., ASCE 90 (IR 2): 21-32. June 1964.

The use of an auxiliary potential function for the purpose of simplifying the numerical analysis of seepage through a nonhomogeneous media was shown to be advantageous. Instead of having to guess at initial trial values for such systems which invariably increase the computational effort required, a systematic procedure demanding a minimum of numerical calculation for any spatial variation in the coefficient of a permeability of the conducting medium is available. For maximum utility, the a priori knowledge of a solution for a homogeneous medium is required. A particular case involving a two-layer system was given to illustrate the technique.

U. Notre Dame, Notre Dame, Ind.

Snow Surveys

19. Washichek, J. N., Stockwell, H. J., and Evans, N. A. SNOW SURVEYS IN COLORADO. Colo. Agr. Expt. Sta. Gen. Series 796, 42 pp. 1963.

Water supply forecasts in Colorado based on mountain snow surveys are an aid to water managers and users in the effective utilization of water. The advance knowledge of water supply through streamflow forecasting can be applied in planning for, and the actual use of, water for maximum economic benefit.

Irrigation water users find streamflow forecasts useful in their annual cropping plans. They have adapted conservation measures and avoided demands in excess of supply in short water years, and have expanded production average in years of more plentiful supply.

Streamflow forecasts are also of value to water users in the fields of municipal water supply and power production. Industries in which operations are affected by annual variations in water supply use streamflow forecast extensively.

The snow surveys and water supply forecasts within the state of Colorado were explained and suggestions on how the forecast information may be used were made.

Agr. Expt. Sta., Colo State U., Fort Collins, Colo.

Ground Water Recharge

20. Clyma, W. ARTIFICIAL GROUNDWATER RECHARGE BY A MULTIPLE-PURPOSE WELL. Tex. Agr. Expt. Sta. MP-712, 7 pp. 1964.

After a 1-hour pumping cycle, 89 to 93 percent of the clay that had entered a multiple-purpose well during the 24-hour recharge cycle was retained in the well. Recharging operations conducted for 3 years reduced the specific capacity of the well from 20 g.p.m. per foot of drawdown to 2 g.p.m. per foot of drawdown. Efforts to redevelop the well using several different procedures increased the specific capacity of the well to 6.5 g.p.m. per foot of drawdown approximately 8 months after the low of 2 g.p.m. per foot of drawdown. The major improvement in yield came after surging caused the well to pump muddy water for several hours. Thus, the reduction in yield was probably caused by sediment.

A chemical reaction between the recharge water and ground water may have occurred in which Ca⁺⁺ (calcium) was added to the recharge water. Recharge operations by a multiple-purpose well utilizing turbid water result in a substantial reduction in well yield or the loss of the well for irrigation.

Tex. A&M U., Tex. Agr. Expt. Sta., College Station, Tex.

WATER MANAGEMENT

Irrigation

SEE ALSO 19, 39, 53, 69, 79, 99, 117, 143, 154, 217, 229.

21. Hershfield, D. M. EFFECTIVE RAINFALL AND IRRIGATION WATER REQUIREMENTS. J. Irrig. and Drain. Div., ASCE, 90 (IR 2): 33-47. June 1964.

An operations analysis designed to simulate soil moisture conditions for various combinations of crops, soils, and climatic data was made to gain both a perspective and a comprehensive picture of effective rainfall and irrigation water requirements in the United States.

A nomogram was presented for estimating the average effective rainfall during the growing-season from the parameters: Seasonal total rainfall; seasonal consumptive use; and application amount.

Another nomogram, using the same independent parameters, was developed to estimate the average amount and 10-yr. return period amount of irrigation water required on a monthly basis. Estimates of consumptive use must be available in order to use these two nomograms. Maps were given that show the geographical distribution of the seasonal effective-total rainfall ratio which varied from less than 50 percent to greater than 95 percent.

SWCRD, ARS, USDA, Beltsville, Md., 20705

22. Hantush, M. S. DEPLETION OF STORAGE, LEAKAGE, AND RIVER FLOW BY GRAVITY WELLS IN SLOPING SANDS. J. Geophysical Res. 69(12): 2551-2560. 1964.

Formulas were obtained for estimating the rate, at any time after pumping begins, and the total volume, at the end of a period of continuous pumping, of the parts of the well yield that were derived from storage, induced leakage, and induced infiltration from the river and/or from the natural flow that would have discharged into the river if the well had not been pumping. It was assumed that the river cuts completely through the sand and flows in a fairly straight course which extends a considerable distance on both sides from the well location. Two cases were considered: A stream cutting across the natural flow; and a stream cutting along the natural flow.

The formulas were applicable provided that the tangent of the tilt of the sloping bed did not exceed 0.02, the drawdown in the well did not exceed 50 percent of the initial depth of saturation, the water levels in the underlying artesian aquifer remain unchanged, the hydraulic conductivity of the water-table aquifer was high relative to that of the semipervious layer, and the depth of saturation at the site of the stream was not influenced by the pumping well.

N. Mex. Inst. Mining and Tech., Socorro, N. Mex.

23. Soderberg, A. D. IRRIGATION DEVELOPMENT IN A SUBHUMID AREA. J. Irrig. and Drain. Div., ASCE 90 (IR 2): 1-19. June 1964.

A successful irrigation development for a subhumid area requires extensive investigations and proper determination of planning criteria. Considerable knowledge and judgement are required in order to satisfactorily establish standards. Major considerations that must be integrated into the plan were listed and outlined.

Procedures and analysis were described for hydrologic, agricultural, and engineering phases involved for the Missouri River project, called the Boswick Division, located in Nebraska and Kansas. Findings to date (1964) of specific criteria were enumerated. Evaluation of present development indicated no significant deficiencies for the investigations or criteria used.

Bur. Reclam. U.S. Dept. Int., Pueblo, Colo.

24. Garton, J. E., Beasley, R. P., and Barefoot, A. D. AUTOMATION OF CUT-BACK FURROW IRRIGATION. Agr. Engin. 45(6): 328-329. \$0.50. 1964.

Furrow irrigation, as commonly practiced, has a high labor requirement and results in non-uniform water application. The uniformity of application can be improved by cut-back irrigation (in which the furrows are watered through with a large initial flow then the flow is reduced to the intake rate of the soil) but this further increases the labor requirement.

A photograph of an automatic cut-back furrow irrigation system installed on the Irrigation Research Station at Altus, Okla., was given. This system has reduced the labor requirement for irrigating the 15 acre field to about 15 minutes per 3-inch irrigation. The labor for this system consists of inserting and removing five sheet metal check dams in the ditch. Current research is aimed at developing solenoid operated gates so that the system can be made more convenient by time clock control.

The means for accomplishing cut-back irrigation was designed into the system. The system consists of a concrete lined ditch constructed as a series of level bays. Level furrow-outlet tubes were set at the same elevation in a given bay. The difference in elevation between bays was equal to the difference in head required on the canopy inlet tubes at initial and cut-back furrow flow. The necessary relation of discharge to head was determined by laboratory tests.

Where it can be used, this system offers the possibility of improving the uniformity of application of furrow irrigation and of reducing the labor requirement to a small fraction of the present amount.

For sale by ASAE, 420 Main St., St. Joseph, Mich., 49085

25. Barton, L. W. SPRINKLING FOR INDUSTRIAL WASTE DISPOSAL. Sprinkler Irrig. Assoc. 1962 Open Tech. Conf. Proc.: 41-45. 1962.

The system of waste water purification and disposal by natural processes consists of proper application of simple biological and engineering principles. There are a large number of factors to be considered in each case, some of which are as follows: (1) Climate; (2) geology and soil factors; (3) topography; (4) nature of cover, if any; (5) seasonal nature of application; (6) volume, total and peak, of effluent; (7) content of effluent; and (8) physical location of plant and disposal area.

Each case is a separate problem, all factors must be studied carefully. Even after a successful start, good management through the years is absolutely essential. This method is by no means a cure-all but offers attractive features of simplicity, ease of installation, low first cost, and low cost of operation.

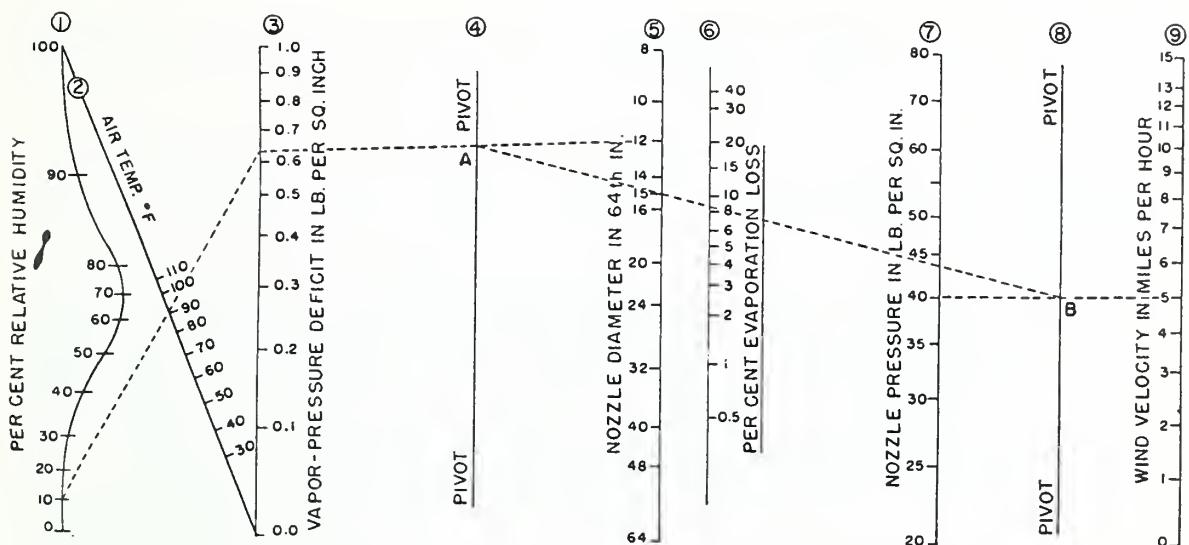
Problems to consider for waste water disposal are:

1. Winter — most food plants in the Northeast operate seasonally so that their peak discharge occurs during temperate months, and in some cases, storage by lagooning can be utilized to take care of the effluent during extreme cold weather. A completely freeze-proof-set-up called "trickling system", not utilizing sprinklers at all, can be installed.
2. Rain — a system that will handle 1-inch per day is not usually bothered by an ordinary rain. When a very heavy rain occurs the dilution is enormous. Food plants are usually shut down or running at low ebb during periods of extreme rainfall.
3. Deterioration of the equipment — where chlorination is required, one can expect more or less rapid stripping of galvanized pipe. High concentrations of alkali or salt do considerable damage to aluminum pipe.
4. Adequate area not available — the best answer is "go out and find one". It is much cheaper to pump considerable distance than to use conventional purification plants or move the factory. The distribution and holding system for two large plants in Bridgeton, N.J., was constructed this summer where it was necessary to construct at 12" cast iron force main 2-1/2 miles, much of it through city and suburban streets.
5. Poorly drained disposal area — in some cases, tile under-drainage is a great help but it is very important that polluted water be kept out of the drains and out of any but the very top layer of soil. All the organisms which do the work of purification are aerobic.
6. Composition of the effluent — frequently an effluent containing a high percentage of suspended solids will be more difficult to handle than one with a high BOD. This relates to the rate of breakdown of the various ingredients in the waste water. Starches and cellulose materials are complex and insoluble and are digested much more slowly by microorganisms than simple sugars and sometimes accumulate on the soil surface.
7. Odors — they are generally an indication of an anaerobic decomposition and they will not be evident in a properly managed system. Odors in storage lagoons can sometimes be controlled with chlorine. Odors in the disposal field indicate an overloaded system.

Lewis W. Barton Co. Haddonfield, N.J.

26. Frost, K. R. EFFICIENCY OF SPRINKLER IRRIGATION. Irrig.: Engin. and Maintance 14(4): 22-23, 28. 1964.

Sprinkler irrigation has been under test at the University of Arizona for the past dozen years. If new systems are to replace present surface irrigation applications they must be efficient, economical, and effective. A well-designed system backed by a dependable organization can compete with present surface installations under dry and hot Southwestern conditions. Investigations in Arizona have shown that the spray losses in most localities are relatively low. Evapotranspiration has been measured accurately during sprinkling periods and results prove conclusively that low rates of application can be used without sacrificing efficiency to satisfy low infiltration rates.



NOMOGRAPH used in estimating spray losses at known climatic and operating conditions. Average daytime conditions for the operating period should be used. Night operation losses can be disregarded unless wind velocities are high. Example shown by the dotted line gives the losses for 10% relative humidity and 90°F air temperature, resulting in vapor pressure deficit of 0.73 psi. Line drawn from 0.73 psi to the nozzle size $12\frac{1}{64}$ " determines point A on line 4. Line drawn from the wind velocity of 5 m.p.h. to the nozzle pressure of 40 psi determines point B on line 8. A line drawn from A to B intersects line 6 at the per cent spray loss.

Recommendations for using nomograph on sprinkler losses in air are:

1. Increase losses taken from the nomograph by 1 percent for each m.p.h. above 5 m.p.h. of wind velocity.
2. Use nomograph losses without correction when sprinkling during the day on complete vegetative cover below 5 m.p.h. wind velocity.
3. When sprinkling on bare ground double nomograph losses.
4. Use 100 percent sprinkler efficiencies at night but make the above appropriate corrections for wind.
5. Low application rates can be used without materially affecting application losses except as influenced by wind.

U. Ariz., Tucson, Ariz.

27. Sale, P. J. M., and Harrison, D. J. SEEDLING EMERGENCE AS AFFECTED BY SOIL CAPPING. J. Hort. Sci. 39(3): 147-161. 1964.

The effect of irrigating a seedbed after sowing was compared with the effect of irrigating before the final cultivation and sowing. The total numbers emerged and rate of emergence of lettuce, spinach, and beet were reduced if the soil surface was

capped by post-sowing irrigation and the cap then dried out; a wet cap did not affect emergence. On the other hand, post-sowing irrigation with small drops, which caused little or no soil capping, tended to increase seedling emergence compared with pre-sowing irrigation when the sowing depth was 1/2-in. or 1-in. Moreover, when lettuce was sown at 1/4-in. depth pre-sowing irrigation gave poor emergence because of rapid drying of the soil round the seed before it could germinate; post-sowing irrigation with small drops again resulted in good emergence, however, as did post-sowing irrigation with large drops if the resulting cap was broken by light cultivation as soon as it dried.

Natl. Veg. Res. Sta., Wellebourne, Warwick, England.

28. Phillips, S. A. COTTON IRRIGATION STUDIES: I. EFFECT OF IRRIGATION ON RESPONSE TO FERTILIZATION, AND II. THE INFLUENCE OF WATER REGIME AND PLANT POPULATION ON COTTON YIELD. La. Agr. Expt. Sta. B. 579, 34 pp. 1964.

The effect of irrigation, fertilization, water regime, and plant population on the yield of cotton and moisture extraction patterns from the soil was determined at Winnsboro, La., on Richland sil and Oliver sil soil for the period 1958-62. The author concluded that:

1. The response of cotton to irrigation must be evaluated over a period of several years. Yield increases due to supplemental irrigation on Richland sil soil ranged from 0 to 1,937 pounds of seed cotton per acre.
2. Irrigation was made more effective by the use of nitrogen. With irrigation and no nitrogen on Richland sil soil the yield increase due to irrigation has ranged from 0 to 1,006 lb./A., with an average increase of 273 lb./A. At the 120 pound rate of nitrogen the yield of cotton ranged from 100 to 1,937 lb./A., with an average increase of 750 lb./A.
3. The total rainfall and distribution was extremely critical during the months of July and August. During the 5 years, two irrigations, one in July and one in August, were required in each year 1958, 1959, and 1960. In 1961, irrigation was not required due to total amount and distribution of rainfall. In 1962, four irrigations were required, two each in July and August.
4. Although significant yield increases were obtained from the 120 pound nitrogen rate in 2 of the 5 years of testing, no reduction in yields occurred in the other 3 years. The inter-action of irrigation and nitrogen rates was significant in 3 of the 5 years of testing.
5. It appears that different nitrogen recommendations can be justified for irrigated and non-irrigated cotton. On Richland sil a nitrogen rate between 90 and 120 lb./A. was recommended for cotton grown under irrigated conditions and 60 to 80 lb./A. for non-irrigated cotton.
6. Due to limitations of the experimental design it was impossible to determine if yield increases were obtained by the addition of 60 pounds of phosphorus and/or potassium.
7. One plant per hill 12-inches apart in the drill on Oliver sil soil was equal to or better than the other plant populations studied. High nitrogen levels under irrigated conditions coupled with a thick plant population and a wet late summer was more conducive to plant lodging and boll rot, thereby reducing cotton yields.
8. Irrigating at approximately the 25 percent available soil moisture level was as effective in increasing yields as irrigating at approximately the 50 percent available soil moisture level.

9. Cotton roots will extract most of their moisture supply from the topsoil in years of ample rainfall. In dry years, more of the moisture needs of the cotton plants will be met by extracting water from greater depths, but the amount which can be extracted will be progressively less as depth increases. In very dry years, moisture was extracted from below the 24-inch depth, but not enough to maintain optimum growth during the critical period of blooming and boll development.

La. State U. and Agr. and Mech. Col., Agr. Expt. Sta., University Station, La.

Drainage

SEE ALSO 103, 114, 171.

29. Ligon, J. T., Kirkham, D., and Johnson, H. P. THE FALLING WATER TABLE BETWEEN OPEN DITCH DRAINS. *Soil Sci.* 97(2): 113-118. 1964.

Equations were derived to predict the location of the falling water table, with time, between parallel, equally spaced ditch drains which were partially filled with water. The derivations were based on an equation giving the shape of the water table due to steady, uniformly distributed rainfall. Comparison of the falling water table in a glass-bead-glycerol drainage model with a series of water tables calculated from the theory showed that, for most of the drainage period, the theory was valid to within a relatively small error. Caution, however, should be used in applying the equation in cases where a significant portion of total flow into the ditches takes place along a surface of seepage.

The case of the falling water table between open ditches partially filled with water was considered, since experimental data were available for comparison with theory. A similar analysis could be made for each of the other six drainage cases for which steady-state solutions were obtained by Kirkham.

Iowa State U., Sci. and Tech., Ames, Iowa.

30. Burke, W. DRAINAGE INVESTIGATION ON BOGLAND: THE EFFECT OF DRAIN SPACING ON GROUND WATER LEVELS. *Irish J. Agr. Res.* 1(1): 31-34. 1961.

Drains installed in blanket peat have a very localized effect. A lowered ground water level was found only to a distance of 5 or 6 feet from the edge of the drain. Hence, with drain spacings of 25, 50, and 100 feet, the areas remaining undrained were respectively 60, 80, and 90 percent. There was a maximum seasonal fluctuation of 12-inches in the water table, but no permanent drainage effect.

An Foras Taluntais, Soil Physics Dept., Kinsale, Co., Dublin, Ireland.

31. Gain, E. W. NATURE AND SCOPE OF SURFACE DRAINAGE IN EASTERN UNITED STATES AND CANADA. *Trans. ASAE* 7(2): 167-169. 1964.

In 1954, the Surface Drainage Committee, ASAE Soil and Water Division, assumed the responsibility of gathering information on subsurface drainage in Eastern United States and Canada and has since presented its findings through meeting papers. The Committee plans to consolidate this information into a symposium of three papers. This first paper covers the nature and scope of lands in the humid East to which surface drainage should apply.

A map was prepared showing the general areas and probable frequency of occurrence of typical sites and soil types requiring surface drainage in the 31 eastern provinces of Canada. This information was compiled from estimates of 75 to 80 engineers and soil scientists located throughout these states and provinces. While no precise values were given, over 100 million acres in these states, and about 8 million acres in the provinces would benefit from surface drainage.

SCS, USDA, Upper Darby, Pa.

32. Dumm, L. D. TRANSIENT-FLOW CONCEPT IN SUBSURFACE DRAINAGE: ITS VALIDITY AND USE. Trans. ASAE 7(2): 142-146, 152. 1964.

A report on the validity and use of the transient flow concept of subsurface drainage was given. Four examples were included.

Charts and tables.

Bur. Reclam., U.S. Dept. Int., Denver, Colo.

33. Fouss, J. L., Holmes, R. G., and Schwab, G. O. AUTOMATIC GRADE CONTROL FOR SUBSURFACE DRAINAGE EQUIPMENT. Trans. ASAE 7(2): 111-113. 1964.

Results of experiments to make an automatic grade control for subsurface drainage equipment were described and illustrated.

The author concluded that the fluid-dampened pendulum as a vertical reference for automatic grade control on a tile trencher or floatingbeam mole plow is very simple in principle. Tests to date have shown that this system provides an economical method of grade control for tile trenchers. It does not eliminate surveying, but requires staking the tile line only at the ends and where grade changes are necessary. These points also serve as check points for the depth of cut. For satisfactory results the machine operator needs to be carefully instructed in its use. Tests showed that this grade-control system maintained as accurate a grade as a careful trencher operator. It was estimated that a pendulum grade-control system could be installed on most tile trenching machines for about \$500. Such a system decreased setup time by about 15 percent by reducing target setting. It also reduced operator fatigue by automating the grade-control operation.

Because of the higher ground speed of the floating-beam mole plow pulled by a crawler tractor, the accuracy of automatic grade control was not as good as for the tile trencher. Research studies are being continued to further develop the automatic grade-control system and to improve its performance, particularly on the mole plow.

SWCRD, ARS, USDA, Columbus, Ohio, 43210

34. Swartzendruber, D. SEEPAGE INTO STRATIFIED WATER-SATURATED SOIL FROM IDEALIZED VERTICAL MULCH CHANNELS. Soil Sci. Soc. Amer. Proc. 28(3): 314-323. 1964.

A general theoretical method of approximating the steady-state, two-dimensional seepage rage in stratified porous media was applied to the problem of water flow into stratified water-saturated soil in the presence of idealized subsoil channels. The approximation, estimated to be accurate within 10 percent, was obtained by considering the stratified system in three special, mathematically degenerate cases for which exact solutions were available. When a less permeable surface soil stratum overlaid a more permeable stratum, the flow effect of the channels always exceeded that found for channels in a uniform soil and became quite marked when the channels penetrated the upper, less permeable stratum and extended into the more permeable stratum below.

If the more permeable stratum overlaid the less permeable stratum, the flow effect of the channels was less than in a uniform soil.

Purdue U., Agr. Expt. Sta., Lafayette, Ind.

35. Shull, H. HYDRAULIC CHARACTERISTICS OF GLASS-FIBER FILTER MATERIALS. Trans. ASAE 7(2): 120-122. 1964.

Subsurface agricultural drainage systems in many areas are installed with a "filter" either fully or partially enclosing the conduit. Gravel is the most common filter material. However, in many areas gravel is in short supply or of a quality not suitable for use as a filter. In the search for a material to substitute for gravel — or improve upon it — several kinds of grass fiber sheet or mat materials have been used as drainage system filters. At the present time subsurface drainage systems, using sleeve-coupled bituminized fiber pipe as conduit with glass fiber mat over the top half of the conduit to serve as a filter, are being installed commercially in the Imperial Valley of California. Water enters the drains through two rows of circular openings under the mat on each side of the conduit, about 2-inches above the conduit center.

Although drainage systems using glass fiber mat as filters appear to be operating satisfactorily in the Imperial Valley, little information is available concerning hydraulic and other characteristics of the material from the drainage filter standpoint. The results of tests conducted to determine the hydraulic characteristics of five different glass-fiber mat materials were described.

The author concluded that the hydraulic conductivity of a filter material must be greater than that of the soil in which it is placed, if the filter is to perform its primary function of improving the hydraulic characteristics of the area surrounding the drain. The glass-fiber mat materials tested met that requirement in most instances.

No data on the performance of glass-fiber mat filters over long periods of time were available. However, preliminary field and tank data show no reduction in hydraulic conductivity of the mat with time.

SWCRD, ARS, USDA, Brawley, Calif., 92227

36. Fukuda, H. SUBDRAINAGE IN HEAVY SOILS: THEORETICAL CONSIDERATIONS. Soil Sci. 97(4): 281-285. 1964.

Most subsoils examined were more dense and heavy and less permeable than the soils above them, and, when disturbed by digging, as in the excavation of a trench for tile drains, the structure and permeability of the soil in the trench was radically altered. In a wet soil, the process of ramming or trampling in produced a puddled condition which caused the filling to become impermeable and water to stand immediately above the tile line. Except for the effects of ramming or trampling in of the soil, the condition of the soil after refilling was much looser than before it was removed. In a clay soil, the material returned to the trench was much more loose and permeable than it was when it was removed, and, as a result, there was a sudden oversaturation and a sudden drainage.

Some theoretical considerations on drainage discharge from tile by which the diameter of the tile could be determined were given for heavy soils.

Inst. Irrig. and Drain., Bunkyo-ku, Tokyo, Japan.

37. Harris, W. S. ROW DRAINAGE OBSERVATIONS IN THE DELTA. Ark. Agr. Expt. Sta. Sp. Rpt. 13, 17 pp. 1964.

Surface drainage observations were made in 185 fields in 12 counties in the Delta Area of eastern Arkansas. The author concluded that:

1. Crop rows drained adequately when the field was free of depressions, the rows or segments of rows had unrestricted outlets, and average grades in row direction equaled or exceeded 0.05 foot fall per 100 feet. "Flats" within the rows did not obstruct drainage provided their lengths did not exceed 100 feet.
2. Crop rows had adequate drainage when provisions were made for the disposal of residual surface water after the principal runoff had ceased.
3. Significant rill erosion occurred only on grades in excess of 0.5 foot fall per 100 feet and in conjunction with abrupt changes to steeper grades. With furrow irrigation, length of grade was not a factor.
4. Deposition was associated with rill erosion in row direction. This deposition was located within the rows when the row grades flattened to 0.5 foot fall per 100 feet or less downslope from the eroded area. Deposition was in the ditches when rill erosion occurred in conjunction with ditch banks.
5. On grades up to 1.0 foot per 100 feet, rill erosion in row direction and resultant deposition did not have an appreciable injurious effect on crops or on mechanized operations except in locations where they occurred in conjunction with ditch banks.
6. Where rows typically drained in the direction of greatest slope and row grades did not exceed 1.0 foot per 100 feet, cross drainage identifiable by rill erosion occurred only in conjunction with reverse grades, regardless of the steepness of side slopes.
7. The row drainage studies were confined to the requirements for drainage.

Agr. Expt. Sta., Div. Agr., U. Ark., Fayetteville, Ark.

38. Schmid, P., and Luthin, J. THE DRAINAGE OF SLOPING LANDS. J. Geophysical Res. 69(8): 1525-1529. 1964.

The problem of the water table in equilibrium with the rainfall on sloping land was analyzed by solving Boussinesq's equation. It was assumed that the hillside was drained by parallel ditches which were founded in the impermeable layer. A nomogram was presented for calculating the ditch spacing as a function of rate of replenishment, soil hydraulic conductivity, and maximum height of the water table above the impermeable layer.

Swiss Federal Inst., Forest Res., Birmensdorf, Zurich, Switzerland.

39. Dumm, L. D., and Winger, R. J., Jr. SUBSURFACE DRAINAGE SYSTEM DESIGN FOR IRRIGATED AREA USING TRANSIENT-FLOW CONCEPT. Trans. ASAE 7(2): 147-151. 1964.

A subsurface drainage system design for an irrigated area using the transient-flow concept was given.

Charts and tables.

Bur. Reclam., U.S. Dept. Int., Denver, Colo.

Storage and Conveyance

SEE ALSO 184.

40. Snyder, F. F. HYDROLOGY OF SPILLWAY DESIGN: LARGE STRUCTURES — ADEQUATE DATA. J. Hydraul. Div., ASCE 90 (HY 3): 239-259. May 1964.

The basic factors to be considered in derivation of conservative spillway design floods were examined. A possible classification of dams was presented with three categories of hazard conditions and associated spillway hydrologic design criteria. Procedures were included that permit an evaluation of the effect of impoundment depth on the peak discharge and the effect of impoundment volume on the transmission downstream of the artificial flood that would result from sudden failure of a dam. A brief review was presented of the considerations involved and the hydrologic procedures used in the derivation of a spillway design flood for a large dam. Estimation of design storm rainfall and snowmelt, runoff determinations, hydrograph development, and flow routing through the reservoir were investigated.

Off. Chief Engin., U.S. Army Corp. Engin., Washington, D.C.

41. Koelzer, V. A., and Bitoun, M. HYDROLOGY OF SPILLWAY DESIGN FLOODS: LARGE STRUCTURES — LIMITED DATA. J. Hydraul. Div. ASCE 90 (HY 3): 261-293. May 1964.

The estimation of probable maximum floods for foreign areas generally involves extrapolation of methods developed in the United States beyond the use for which they were originally intended.

Available data generally are less than desirable for such analyses. The hydrologic engineer should recommend rapid expansion of data collection, but he cannot refuse to accept the responsibility of making an estimate of the probable maximum flood.

The necessity of making estimates of factors involved in design flood determination on the basis of extremely limited data may frequently result in an over-estimation of the individual factors. The compounding of these over-estimations probably results in design floods that, on the average, are greater than they would have to be if adequate data were available. Spillways are an important item of cost, but in many designs the spillway gates merely replace a portion of the dam structure that would have to be provided if the spillways were not as large as designed. Hence, the true cost of over-designing a spillway is only the difference between the incremental costs of the spillway and an equivalent portion of the dam. Moreover, if there is an over-design of the spillway, this incremental cost is a small price to pay for the assured safety of lives and property downstream.

In the final analysis, the selection of a design flood is based, to a very great extent, on judgement. Selection of a design flood purely on the basis of judgement, without detailed analysis, might easily result in the use of a normal value from a curve. Detailed studies may reveal reasons why the potential of a given river basin is different from the normal value, thereby representing the difference between safety and disaster.

Harza Engin. Co., Chicago, Ill.

42. Ogrosky, H. O. HYDROLOGY OF SPILLWAY DESIGN: SMALL STRUCTURES — LIMITED DATA. J. Hydraul. Div. ASCE 90 (HY 3): 295-310. May 1964.

A classification of small dams and minimum spillway design criteria for such dams, currently in use by the Soil Conservation Service was presented for the United States. The classification of dams took into account the physical characteristics of

the valley below a dam site and the present and potential economical development of that area. Because nearly all sites for small dams were located in watersheds for which there were little or no hydrologic data available, the minimum spillway design criteria were based on rainfall data analyses performed by the U.S. Weather Bureau. The criteria were applied through the use of five maps of minimum rainfall amounts for storms of 6 hours duration. These amounts were used in both spillway design and the determination of freeboard.

A method of design hydrograph development was briefly outlined. The elements for such development were: The design storm rainfall; watershed characteristics that were easily determined; a broadly applicable rainfall-runoff relation; and a dimensionless unit hydrograph. All of these were illustrated or discussed. By use of standardized hydrologic techniques, it was possible to establish a high level of hydrologic design practice, even for areas with limited hydrologic data. Peak flows of typical spillway design floods were shown with Myers' ratings for comparison.

SCS, USDA, Washington, D.C., 20250

BASIC SOIL SCIENCE
Soil Physics

SEE ALSO 10, 12, 14, 34, 60, 82, 92, 105, 107, 135, 138, 151, 154, 171, 172, 204, 296.

43. Davis, R. J., Jr., and Heald, W. R. FORMATION OF CLAY MINERAL-RHIZOBIAL POLYSACCHARIDE GELS AND THEIR MEASUREMENT BY TORQUE VISCOMETRY. Soil Sci. Soc. Amer. Proc. 28(2): 203-205. 1964.

Microbial gums were shown to bind soil particles and influence the soil physical properties. This binding effect is not clearly understood but may be related to gel stability.

The gel-forming characteristics of several Rhizobial polysaccharides and clay mixtures were studied using a torque-type viscometer. This method gave a more rapid and precise measure of the total effect of the added compound to clay than the floc volume method. Krillium and dextran were used as comparison compounds. Krillium greatly influenced the viscosity of clay suspensions, but dextran had no effect. All rhizobial polysaccharides used had some effect on the properties measured, and most compared favorably with Krillium.

SWCRD, ARS, USDA, Beltsville, Md., 20705

44. Cary, J. W., Kohl, R. A., and Taylor, S. A. WATER ADSORPTION BY DRY SOIL AND ITS THERMODYNAMIC FUNCTIONS. Soil Sci. Soc. Amer. Proc. 28(3): 309-314. 1964.

The adsorption of increments of water vapor on Millville 1 soil was studied in an air-free system. The resulting data included the amount of water that would condense on the soil at different relative humidities up to 90 percent at 14.8°, 24.8°, and 34.8° C. The temperature rise of the samples during adsorption was also recorded and the heat liberated during the reaction was calculated. Both integral and differential thermodynamic values were computed. A critical evaluation of the entropy function showed the integral values to be more useful than the differential values so far as describing the physical state of the system was concerned. In general, calculations of thermodynamic quantities based on the temperature dependence of the systems proved to be unreliable at low relative humidities due to changes in the available surface.

When equilibrium relative humidity was < 80 percent in an air-free Millville 1 system, the average entropy of the absorbed film was a little greater than that of

corresponding liquid water. The average internal energy of the film was always less than that of liquid water, even though the heat content became slightly greater as the relative humidity exceeded 70 percent.

U. Calif., Davis, Calif.

45. Zaslavsky, D. THEORY OF UNSATURATED FLOW INTO A NON-UNIFORM SOIL PROFILE. *Soil Sci.* 97(6): 400-410. 1964.

Theoretical study was made for one-dimensional steady-water infiltration into a soil of non-uniform hydraulic conductivity. Two types of soil were considered, one with distinct layers, each of different hydraulic conductivity, and the other with gradually varying hydraulic conductivity.

Unsaturated flow occurs when the water head at the soil surface is low and when the hydraulic resistance near the point of water entry is high. Saturated flow occurs under high water heads, and low resistance at the point of entry.

Analysis was made as to the shapes of pressure distribution with depth. The analysis was made for both vertical flow and diagonal flow. The conditions for forming perched water horizon were stated.

Israel Inst. Tech., Technion City, Haifa, Israel.

46. Wang, F. C., Hassan, N. A., and Franzini, J. B. A METHOD OF ANALYZING UNSTEADY, UNSATURATED FLOW IN SOILS. *J. Geophysical Res.* 69(12): 2569-2577. 1964.

A numerical method of analyzing unsteady, unsaturated flow in soils was presented. When the hydraulic and capillary characteristics of the soil and the initial moisture condition were known, the method permitted prediction of the future disposition of soil moisture as a function of time and location. The technique was particularly adaptable to problems of infiltration, drainage, and upward flow induced by evaporation. Effects of hysteresis and vapor movement were neglected. Darcy's law was combined with the continuity principle, and the solution was achieved through a step-by-step numerical procedure. Soil moisture profiles were obtained from a digital computer. At the present stage of development, the method was applicable only to idealized soils.

Harvard U., Water Resources Study Group, Cambridge, Mass.

47. Kunze, R. J., and Kirkham, D. CAPILLARY DIFFUSION AND SELF-DIFFUSION OF SOIL WATER. *Soil Sci.* 97(3): 145-151. Mar. 1964.

The capillary diffusion coefficient (D_C) and molecular self-diffusion coefficient (D_S) for the liquid phase of soil water were determined for three moist soils (silt loam, silty clay loam, and clay) over a wide range of their moisture contents. A curve fitting the data points of D_C versus D_S was found to be, within experimental error, the same curve, for the three soils. The curve was expressed in the form of a theoretical relationship.

SWCRD, ARS, USDA, St. Paul, Minn., 55101

48. Kemper, W. D., Maasland, D. E. L., and Porter, L. K. MOBILITY OF WATER ADJACENT TO MINERAL SURFACES. *Soil Sci. Soc. Amer. Proc.* 28(2): 164-167. 1964.

Mobility of water adjacent to Na- and Ca-saturated bentonite surfaces was estimated from diffusion rates of deuterium hydroxide in oriented clay pastes at several moisture contents. The first molecular layer of adsorbed water on Na- and Ca-clays had mobilities which were 30 and 5 percent, respectively, of the mobility of water molecules in bulk water. There was an indication of a slight reduction in mobility of water as far as 40 \AA . from the sodium-saturated clay. However, water more than three molecular layers from the solid surface had mobilities which were 60 percent of the mobility in bulk water. The mobility data indicate that water outside the first adsorbed molecular layer does not have viscosities more than 2.5 times the viscosity of bulk water.

SWCRD, ARS, USDA, Fort Collins, Colo., 80521

49. Jackson, R. D. WATER VAPOR DIFFUSION IN RELATIVELY DRY SOIL: I. THEORETICAL CONSIDERATIONS AND SORPTION EXPERIMENTS. *Soil Sci. Soc. Amer. Proc.* 28(2): 172-176. 1964.

Water transfer was measured in three soil materials at water content ranges corresponding to a relative pressure range of 0.97 to about 0.05. At these water contents vapor flow was probably the predominant transfer mechanism. The data were obtained from a transient sorption experiment and diffusion coefficients were calculated from analyses of water content distribution curves. The evaporation-condensation reaction between the liquid and vapor phases was treated by using simultaneous diffusion-reaction theory. Within the water content ranges used, the diffusion coefficients increased and then decreased with increased water content.

SWCRD, ARS, USDA, Tempe, Ariz., 85281

50. Flannery, R. D., and Kirkham, D. A SOIL CORE WATER PERMEAMETER FOR FIELD USE. *Soil Sci.* 97(4): 233-241. 1964.

Simple and easy-to-make field core permeameter equipment was described. The equipment was used to determine, for use in reclamation work, hydraulic conductivities of essentially undisturbed field soil. The equipment was easy to use and the formulas for reducing the permeameter data were very simple.

The equipment was applied to obtain vertical and horizontal hydraulic conductivities of a single soil layer as well as to obtain composite hydraulic conductivities of a number of layers. The cost of parts and assembly was low, so the equipment could be economically used for widespread testing over fairly large areas. A table of hydraulic conductivities and associated data was presented and discussed.

Jr. Author, Iowa State U. Sci. and Tech., Ames, Iowa.

51. Boelter, D. H., and Blake, G. R. IMPORTANCE OF VOLUMETRIC EXPRESSION OF WATER CONTENTS OF ORGANIC SOILS. *Soil Sci. Soc. Amer. Proc.* 28(2): 176-178. 1964.

Methods for evaluating water contents and bulk densities of several different peats were compared. Because bulk densities (saturated volume basis) of moss, herbaceous, and aggregated peats varied from 0.028. to 0.249 g. per cc., a highly distorted impression of the amount of water actually held under field conditions is given if water values are expressed on an oven-dry weight basis.

On a wet-volume basis, moss peat held only 10 to 20 percent more water at saturation than did herbaceous and aggregated peat and retained less water than they did at higher suctions. Between 0.1 and 15 bars, moss peat retained about one-quarter the volume of water of a medium-textured mineral soil, Barnes 1.

Since considerable volume reduction occurs on drying, bulk density of oven-dry peat, D_b (dry volume basis), represents an artificial condition rarely, if ever, occurring in undrained bogs. Bulk densities must, therefore, be calculated on the basis of the wet bulk volume and are referred to as D_w (wet bulk volume). A more precise expression of degree of wetness may be substituted for "wet" in the wet volume basis term.

Lake States Forest Expt. Sta., FS, USDA, St. Paul, Minn.

52. Adams, J. E., and Hanks, R. J. EVAPORATION FROM SOIL SHRINKAGE CRACKS. Soil Sci. Soc. Amer. Proc. 28(2): 281-284. 1964.

Field and laboratory studies have shown that evaporation from shrinkage cracks may equal or exceed that from surface soil. Evaporation from moist soil samples (soil atmometers), suspended at various depths in naturally occurring shrinkage cracks in Houston Black c, was determined. During the first 19 hours, the moisture evaporated at the 24-inch depth was 55 percent of that evaporated at the surface. Soil atmometers suspended at the depths of 12 inches or less were reduced from 55 percent soil moisture to < 17 percent in 44 hours. Crop cover affects evaporation in shrinkage cracks. Atmometers at the 12-inch depth in grain sorghum lost half as much water as atmometers at the same depth in corn or permanent pasture. There was from 2.9 to 4.6 times more surface area exposed on the shrinkage crack walls than on surface soil per square yard.

Evaporation from the side walls of shallow shrinkage cracks varied from 35 to 91 percent of that from a comparable area of surface soil depending on soil moisture content. Wind tunnel studies with a simulated shrinkage crack 20 inches deep showed that evaporation increased at all depths as surface wind velocity increased. Increasing the wind velocity from calm to 25 m.p.h. increased evaporation 570 percent at 2-inches below the surface and 100 percent at 18-inches. Evaporation increased as crack width decreased from 2.75 inches to 1.75 inches.

SWCRD, ARS, USDA, Temple, Tex., 76502

53. Meek, B. D., MacKenzie, A. J., Stockinger, K. R. EVALUATION OF A RADIOACTIVE TRACER METHOD FOR MEASURING WATER INTAKE OF SOILS. Soil Sci. Soc. Amer. Proc. 28(2): 153-155. 1964.

A tracer method of measuring water intake by application of radioactive gold in the irrigation water was evaluated. When irrigation water containing a constant known amount of isotope was applied to the soil, the amount of isotope adsorbed was proportional to the amount of water entering the soil. To calculate water intake the amount of isotope adsorbed was determined by measuring the activity of soil samples taken in the field. Two factors, vertical distribution of the tracer in the soil, and magnitude of adsorption on the soil surface from flowing irrigation water, were studied.

The radioactive tracer was not measurably lost by adsorption from the tagged water as it flowed over the soil surface. It was adsorbed near the soil surface and sampling to a depth of 6 cm. recovered 95 percent of the gold in Holtville cl. The method was used to determine water intake variability. Samples within a plot had an average coefficient of variability of 9 percent. This would require 7 samples to determine the mean water intake within 10 percent at the 1 percent level.

The method was limited to the measurement of water intake and did not measure water movement after the water had entered the soil.

SWCRD, ARS, USDA, Brawley, Calif., 92227

Soil Chemistry and Minerology

SEE ALSO 43, 48, 80, 82, 83, 85, 89, 90, 91, 92, 93, 94, 99, 101, 102, 103, 105, 109, 111, 112, 116, 118, 139, 146, 150, 160, 163, 165, 166, 167, 169, 170, 172, 173, 295.

54. Kyuma, K., and Kawaguchi, K. OXIDATIVE CHANGES OF POLYPHENOS AS INFLUENCED BY ALLOPHANE. *Soil Sci. Soc. Amer. Proc.* 28(3): 371-374. 1964.

Oxidative changes of polyphenols as influenced by allophane were studies in relation to humus-forming processes in Ando soils. A chestnut tannin-containing substrata was incubated for varying lengths of time with an allophanic material, and changes in the shape of ultraviolet (UV) and infrared (IR) spectra and in neutralization capacity of the polyphenols were traced with time. As compared with control materials, the allophanic material absorbed large amounts of organic carbon (8 to 10 times as much at the end of 22 weeks), and the adsorbed organic matter kept incubated for only 2 weeks showed the following features: (1) No sharp peaks in UV spectrum at the 280 μm region which is characteristic of tannin; (2) high optical density (about 20 times as high at 400 μm as that of tannin); (3) high neutralization capacity (416 me. per 50 g. carbon, which is about three times as high as that on tannin); and (4) strong 5.8 to 5.9 μ band in IR spectrum instead of a weak shoulder as for tannin. All these remarkable changes occurring in a very short period of time suggested that allophane might have some catalytic effect on oxidative changes of polyphenols, and a manometric determination of oxygen absorption confirmed this supposition. Such catalytic effect exerted by allophane would have great significance in humus formation and accumulation in Ando soils.

Kyoto U., Kyoto, Japan.

55. DeMumbrum, L. E., and Chesters, G. ISOLATION AND CHARACTERIZATION OF SOME SOIL ALLOPHANES. *Soil Sci. Soc. Amer. Proc.* 28(3): 355-359. 1964.

A fractionation procedure based on H-dispersion was used to concentrate inorganic amorphous colloidal materials from several soils. Concentrate was evaluated by use of X-ray diffraction, infrared absorption, electron microscopy, and chemical techniques. The allophanes were metallic silicates, largely hydrous aluminum silicate, which may be a residue of chemical weathering within the soil profiles. In the B and C horizons examined, microcrystalline particles of halloysite were intimately mixed with the amorphous residues. The presence of amorphous $\text{Al}(\text{OH})_3$ (or related polymers) in the allophanes was suggested.

U. Wis., Madison, Wis.

56. Kemper, W. D., and Maasland, D. E. L. REDUCTION IN SALT CONTENT OF SOLUTION ON PASSING THROUGH THIN FILMS ADJACENT TO CHARGED SURFACES. *Soil Sci. Soc. Amer. Proc.* 28(3): 318-323. 1964.

An equation was derived to measure the effect of salt and water diffusion on salt reduction of solutions forced through thin films of water by pressure differentials. Salt concentrations of solutions which had passed through thin films adjacent to charged particles were calculated from the equation and were plotted as a function of pressure differential, ionic mobility, film thicknesses, and cation valences. Experimental evidence showed that salt sieving increased as the pressure forcing solution through the clays increased. Salt sieving generally increased as the pores through which the water flows decreased in size, and was smaller when the soil was saturated with divalent rather than monovalent ions. These observations were in a agreement with the theory.

SWCRD, ARS, USDA, Colo. State U., Fort Collins, Colo., 80521

57. Coleman, N. T., and Thomas, G. W. BUFFER CURVES OF ACID CLAYS AS AFFECTED BY THE PRESENCE OF FERRIC IRON AND ALUMINUM. Soil Sci. Soc. Amer. Proc. 28(2): 187-190. 1964.

Buffer curves of Al- or Fe-montmorillonites and hectorite in 1.0 N KCl had appreciably smaller slopes between pH 5 and 8.5 than did curves for corresponding H-clays. Aluminum or ferric hydrous oxide-clay complexes gave buffer curves indicative of almost no exchangeable Al, Fe, or H on permanent-charge sites, but rather showed a regular increase in pH with additions of NaOH.

The behavior of the clay-sesquioxide complexes was thought due to the existence, at pH below about 5, of hydroxy-Al or Fe-ions on exchange sites, with the progressive conversion of these to the corresponding hydroxides upon the addition of base. That such a reaction can result in apparent pH-dependent cation-exchange capacity (CEC) was shown by the reasonably good correspondence between CEC's measured at various pH values and the amounts of base necessary to titrate the complexes to those pH's. It was suggested that the pH-dependent CEC's of some soils may be due to the presence of clay-sesquioxide complexes. In other cases, apparent pH-dependent exchange capacity can be "created" during the neutralization of Al- or Fe-clay, through the interaction of positively charged metal ion-hydroxy complexes with exchange sites.

Aluminum- or Fe-hydroxy complexes with montmorillonite were not stable upon digestion in dilute salt solutions, but underwent dismutation to produce the corresponding metal ion and hydroxide. While sesquioxide-montmorillonite complexes resembled many acid soils so far as titration behavior and pH-dependent CEC were concerned, the chlorite-like complexes were far less stable than those found in soils.

U. Calif., Citrus Res. Cent. and Agr. Res. Sta., Riverside, Calif.

58. Sawhney, B. L. SORPTION AND FIXATION OF MICROQUANTITIES OF CESIUM BY CLAY MINERALS: EFFECT OF SATURATING CATIONS. Soil Sci. Soc. Amer. Proc. 28(2): 183-186. 1964.

Sorption and fixation of microquantities of Cs by six minerals, as affected by the saturating cations, were studied. Micas and vermiculite sorbed more Cs in the presence of Ca and similar divalent cations than in the presence of K and similar monovalent cations. Montmorillonite and kaolinite, on the other hand, sorbed more Cs in the presence of K than in the presence of Ca. While micas and vermiculite fixed large proportion of the Cs sorbed, montmorillonite and kaolinite did not fix significant amounts of Cs against replacement by neutral salts. Cs-sorption by montmorillonite and kaolinite appeared to be largely electrostatic, while the sorption and fixation of Cs by micas and vermiculite was governed by the size and hydration, rather than valence, of the competing cation. Micas particularly exhibited a large fixation of Cs. It was suggested that the fixation of Cs by micas occurs at the crystal edges where Cs may replace K and thus become a part of the stable mica structure.

Conn. Agr. Expt. Sta., New Haven, Conn.

59. Bingham, F. T., Page, A. L., and Sims, J. R. RETENTION OF Cu AND Zn BY H-MONTMORILLONITE. Soil Sci. Soc. Amer. Proc. 28(3): 351-354. 1964.

Studies were conducted on the retention of Cu and Zn by H-montmorillonite in relation to associated anion, salt concentration, reaction time, pH of the equilibrium solution, and techniques.

Under conditions where the pH of the equilibrium solution was too acid for formation of $\text{Cu}(\text{OH})_2$, the amounts of Cu and Zn retained were similar for Cl^- , NO_3^- , and SO_4^{2-} salts and equal to the cation-exchange capacity (CEC) as measured with NH_4^+ . Detailed studies of metal retention in relation to pH of equilibrium solutions for Cl

systems revealed no retention of Cu or Zn in excess of the CEC provided the pH of the system was below 5.5 to 6.5. The exact pH favoring excess retention varied according to salt concentration and the metal in question. Retention of the metals in excess of the CEC was explained in terms of precipitation of $\text{Cu}(\text{OH})_2$ and $\text{Zn}(\text{OH})_2$ in the clay systems.

In the acetate systems, Cu and Zn retention was usually greater than the CEC even under acid conditions. As the pH of the systems increased, metal retention increased. In addition to metal retention, acetate retention was measured. Acetate retention was related to the concentration of acetate and essentially independent of the quantity of metal retained.

U. Calif. Citrus Res. Cent., Agr. Expt. Sta., Riverside, Calif.

60. Patrick, W. H., Jr., Wyatt, R., and Brupbacher, R. H. A STUDY OF CHEMICAL AND PHYSICAL PROPERTIES OF THREE ALLUVIAL SOILS IN THE SUGAR CANE AREA OF LOUISIANA. La. Agr. Expt. Sta. B. 580, 19 pp. 1964.

A study was made of certain physical and chemical properties of the Ap horizon of three important soil series of alluvial origin in the sugar cane area of Louisiana. These soils occur on the natural levees of the channel now occupied by Bayou Teche in South Louisiana.

The better drained Cypremort soils, occurring at the highest elevations and closest to the stream channel, had the coarsest texture, lowest organic matter content, and the lowest aggregation. They also contained the lowest levels of mineral nutrients. The very poorly drained and fine-textured Iberia soils, occurring farthest from the channel at the lowest elevations was highest in organic matter, percent aggregation, and content of mineral nutrients. The Baldwin soils, generally lying between the Cypremort and Iberia soils, were intermediate in physical properties and extractable nutrients. An exception to this pattern was extractable potassium which was slightly higher in the Baldwin soils than in the Iberia soils.

The interrelations of the various physical and chemical properties were studied. One-third and 15-atmosphere moisture percentages were closely related to clay content. A maximum available water-holding capacity of 20.3 percent occurred at a clay content of 37.1 percent. Ninety-five percent of the variation in cation exchange capacity could be accounted for by variations in organic matter content and clay content. Aggregation was also closely related to both organic matter and clay. Because of the close association between organic matter and clay, it was difficult to measure their separate effects on aggregation.

La. State U. and Agr. and Mech. Col., Agr. Expt. Sta., University Station, La.

61. Johnson, R. E., and Jackson, W. A. CALCIUM UPTAKE AND TRANSPORT BY WHEAT SEEDLINGS AS AFFECTED BY ALUMINUM. Soil Sci. Soc. Amer. Proc. 28(3): 381-386. 1964.

Uptake and distribution of Ca was studied with excised roots and intact seedlings of wheat. Patterns characteristic of inorganic ion uptake by roots were obtained, namely a rapid initial adsorption phase followed by a linear rate of accumulation. The former was relatively large compared to the latter. It also was reduced to a greater extent by increasing acidity from pH 6 to pH 4. The Ca accumulation phase was reduced by modest restrictions in aerobic metabolism. Treatments resulting in severe reductions in metabolism produced a loss of isotopic procedures for ion uptake studies under such extreme conditions.

Aluminum treatments reduced both the adsorption and accumulation phases of Ca uptake. The reduction in the accumulation phase could not be overcome by supplying additional Ca. Increasing the Al concentration from 10^{-4} N to 10^{-3} N at constant Ca did not alter the extent of inhibition, suggesting that a portion of the Ca accumulation mechanism was inactivated completely by Al at 10^{-4} N or less.

Transport of Ca to shoots of intact seedlings also was restricted by Al although appreciable transport still occurred when root uptake was inhibited completely.

USDA, Reg. Soybean Lab., Urbana, Ill.

62. Fleming, G. A. SOME FACTORS AFFECTING THE UPTAKE OF SELENIUM BY PLANTS. Irish J. Agr. Res. 1(2): 131-138. 1962.

Superphosphate added to naturally seleniferous soil decreased the selenium content of the herbage while barium chloride was without effect. When selenate and selenite were added to a selenium-free soil, the selenate was more freely absorbed by red clover and perennial ryegrass, and in the case of the clover a marked depression in growth was noted.

An Foras Taluntais (The Agricultural Institute), Soils Div., Johnstown Castle Col. Agr., Wexford, Ireland.

63. Binnie, R. R., and Barber, S. A. CONTRASTING RELEASE CHARACTERISTICS OF POTASSIUM IN ALLUVIAL AND ASSOCIATED UPLAND SOILS OF INDIANA. Soil Sci. Soc. Amer. Proc. 28(3): 387-390. 1964.

The uptake of K from alluvial soils was similar to that from associated upland soils under low cropping intensity. Under the high intensity cropping of a Neubauer experiment, the alluvial soils released more K. Within the exchangeable K range 40 to 180 p.p.m., K uptake was 67 p.p.m. greater from the alluvial soils than from the associated upland soils at the same exchangeable K level. The reduction of exchangeable K in the soil due to crop removal was greater in the upland than in the alluvial soils. There was no statistical correlation between the mineralogical composition of the soil and the K released.

U.S. Army Elect. Res. and Develop. Activ., Fort Huachuca, Ariz.

64. Bhide, V. K., and Motiramani, D. P. EFFECT OF FERTILIZERS ON AVAILABLE POTASSIUM IN SOILS OF MADHYA PRADESH. J. Indian Soc. Soil Sci. 12(1): 37-42. 1964.

A study of the effect of N, P, and K fertilizers on the availability of potassium in four soil types of Madhya Pradesh showed that ammonium sulphate at the rate of 30 and 60 lb. N/A. significantly decreased the availability of soil potassium in all cases. Superphosphate at 30 lb. P₂O₅/A. had no effect and the 60 lb. dose at 15 and 30 days was not effective but the latter showed a significant decrease at 45 days. Muriate of potash at 30 and 60 lb. K₂O/A., with or without a basal dose of N and P, increased the available potassium in all soils. When used in combinations, only NP and NK interactions were found significant.

Nitrogen in combination decreased the available K while potash application increased it. Effect of phosphate was not consistent. It appears potash fixation was predominant up to 16 days or less after which there was little fixation or release till 30 days and thereafter a release of fixed potassium took place resulting in an increase in available soil potassium as observed on the 45th day.

Agr. Col., Gwalior, Madhya Pradesh, India.

65. Beckett, P. POTASSIUM-CALCIUM EXCHANGE EQUILIBRIA IN SOILS: SPECIFIC ADSORPTION SITES FOR POTASSIUM. *Soil Sci.* 97(6): 376-383. 1964.

The equilibrium between potassium and calcium ions held on the exchange surfaces in field soils was adequately described by equations of the Gapon or Eriksson type only when the soil already held a certain amount of exchangeable potassium. The exchange equilibrium involving this first quantity of exchangeable potassium was best described by an equation like the Langmuir adsorption isotherm. We may infer that a certain number of potassium ions are held at sites possessing a specific binding power for potassium.

The results of some preliminary measurements of the thermodynamic functions of the exchange system were consistent with this inference, though not sufficiently accurate to be conclusive.

In particular, the entropy of exchange of potassium ions, held by a soil of low exchangeable potassium content, had an anomalously high value. This could be because the potassium ions held at specific sites have an incomplete hydration shell or because the presence of both specific and nonspecific adsorption sites reduced the number of ways of distributing exchangeable ions on the surface. It is possible that the specific sites may be in intra-lattice positions at the edges of the clay crystals, but this needs further proof.

Soil Sci. Lab., Oxford, England.

66. Rich, C. I., and Black, W. R. POTASSIUM EXCHANGE AS AFFECTED BY CATION SIZE, pH, AND MINERAL STRUCTURE. *Soil Sci.* 97(6): 384-390. 1964.

It was recently found that NH_4OAc was much more effective than $\text{Mg}(\text{OAc})_2$ in removing exchangeable K^+ from two Coastal Plain soils in Virginia.

A study of 14 acid soils from the southeastern and midwestern United States showed that neutral NH_4OAc was more effective in displacing K than neutral $\text{Mg}(\text{OAc})_2$, but that MgCl_2 was as effective as NH_4OAc . Exchangeable Ca^{++} was removed effectively by all three salt solutions. To explain these results, it was proposed that exchangeable K^+ is not uniformly distributed over the exchange material but that a portion of it is present at wedge-shaped interlayer spaces of partially "opened" micas and partially "closed" vermiculite and montmorillonite. In such positions, K^+ is exchanged rapidly only by small ions, such as NH_4^+ , or by hydrogen ions through proton or hydrogen bond transfer. K^+ and NH_4^+ fixation in such soils is inhibited by hydroxy-Al and Fe interlayer "props."

Va. Polytech. Inst., Blacksburg, Va.

67. Soileau, J. M., Jackson, W. A., and McCracken, R. J. CUTANS (CLAY FILMS) AND POTASSIUM AVAILABILITY TO PLANTS. *J. Soil Sci.* 15(1): 117-123. 1964.

The influences of iron-kaolinite cutans enveloping soil aggregates on the availability of K within these aggregates were studied. Macroscopic and microscopic observations of the synthetically prepared aggregates indicated the formation of almost continuous, partially orientated crystalline iron-kaolinite cutans around the perimeter. There were indications that the presence of the coating tended to stabilize the aggregates. Photo-micrographs of wheat root-aggregate associations revealed intimate surface contact between the two with some penetration and disruption by the wheat roots, both in the coated and uncoated aggregates.

Plant growth and potassium uptake were restricted in the presence of iron-kaolinite coatings on K-rich illite aggregates compared with plants grown on aggregates without coatings. Moreover, the presence of the coatings resulted in appreciable increases in Ca and Mg accumulation by the plants.

The results indicated that cutans may modify significantly ion availability and accumulation by plants growing in highly weathered, iron-rich soils.

TVA, Wilson Dam, Ala.

68. Thomas, G. W., and Coleman, N. T. THE FATE OF EXCHANGEABLE IRON IN ACID CLAY SYSTEMS. *Soil Sci.* 97(4): 229-232. 1964.

It was demonstrated that exchangeable Fe^{+3} is not stable, but tends to hydrolyze in clay systems. The hydrogen formed dissolves lattice and/or extra-lattice cations at a rate reflecting the ability of the exchanger to accept hydrogen ions. This gives aluminum saturation in montmorillonite and soils, magnesium saturation in hectorite and vermiculite, and iron saturation in nontronite. The iron does not hydrolyze completely to ferric hydroxide, but retains enough charge so that the amount of "effective" cation-exchange capacity (CEC) blocked is roughly a function of nonexchangeable iron adsorbed.

Treatments which increase hydrolysis, such as heating or salt additions, drive the reaction nearly to completion even in the most stable exchangers. In acid soils, hydrolysis of iron results in the appearance of exchangeable Al^{+3} , the absence of exchangeable Fe^{+3} , the build-up of nonexchangeable hydrous iron oxides, and the reduction of effective CEC. Older soils show all these properties to a marked degree, which leads to the conclusion that this reaction is of great importance under natural conditions.

U. Calif., Riverside, Calif.

69. Fox, R. L., Olson, R. A., and Rhoades, H. F. EVALUATING THE SULFUR STATUS OF SOILS BY PLANT AND SOIL TESTS. *Soil Sci. Soc. Amer. Proc.* 28(2): 243-246. 1964.

Several methods for evaluating the sulfur status of soils were compared. Among chemical procedures used, water and phosphate extractions gave the best agreement with sulfur A values and total sulfur uptake by alfalfa from Nebraska soils. Water was an inefficient extractant of sulfate from a Hawaiian Latosol. Calcium phosphate solution was a more convenient extractant than KH_2PO_4 for both Nebraska and Hawaii soils.

The sulfur content of precipitation should be considered when interpreting soil test values and crop response to S fertilizers. In Nebraska, the S received through precipitation increased with population density and rainfall received, varying from 4 to 12 lb./A. per year. Field response to S fertilization may be obtained at higher soil test values in remote areas than occurs in more populous area. On the other hand, supplemental water application modified the S balance sheet quite radically in favor of S accumulation in most irrigated soils. There was a range from 4 to 1,500 pounds S per acre-foot among surface- and ground-waters of Nebraska which were analyzed, with a representative median of 45 pounds.

U. Hawaii, Honolulu, Hawaii.

70. Nelson, L. E. STATUS AND TRANSFORMATION OF SULFUR IN MISSISSIPPI SOILS. *Soil Sci.* 97(5): 300-306. May 1964.

The sulfur status and organic sulfur mineralization of 12 Mississippi soils were studied. Organic sulfur contents ranged from 57 to 353 lb./A. and were highly correlated with organic carbon, total nitrogen, and total sulfur. The average quantities of $\text{SO}_4^{--}\text{-S}$ released after 1-, 2-, 3-, and 6-month incubation were 2.1, 3.9, 5.4, and 8.9 lb./A., respectively. The release curves for individual soils, however, show that the

pattern of release varies with an initial release or fixation of $\text{SO}_4^{--}\text{-S}$ during the first 2 months of incubation, followed by a rather constant rate of release after the second month. The total amount of sulfur mineralized was related to the level of organic sulfur in the soil.

The ratios of nitrogen to sulfur mineralized for the 2-, 3-, and 6-month samples were 4.8, 6.5, and 5.8, respectively. The ratio of carbon loss to nitrogen mineralization to sulfur mineralization was 277:10:1.9 compared to a C:N:S ratio of 126:10:1.1 at the beginning of incubation.

Miss. Agr. Expt. Sta., Miss. State U., State College, Miss.

71. Brown, A. L., Krantz, B. A., and Martin, P. E. THE RESIDUAL EFFECT OF ZINC APPLIED TO SOILS. *Soil Sci. Soc. Amer. Proc.* 28(2): 236-238. 1964.

Greenhouse tests with sweet corn were studied to measure the residual effect of soil applied Zn.

Of the six soils, four had been shown to be Zn deficient by previous tests. Ten successive crops were grown in these soils to which had been applied, 0, 4, and 20 mg. Zn per 1,600 g. of soil.

Dry weight yields showed that the 4-mg. Zn rate was adequate for 6 or 7 successive crops; the pots to which 20 mg. was added were not in the deficient range even after 10 crops. The two soils that were not deficient produced 10 crops without any deficiency symptoms developing or any growth response to the Zn applications.

Dithizone-extractable soil Zn decreased gradually with cropping. When the values dropped below 0.55 p.p.m. there was a plant growth response to Zn.

Alfalfa was found to obtain adequate Zn from soils which were inadequate for sweet corn.

U. Calif., Davis, Calif.

72. Vámos, R. THE RELEASE OF HYDROGEN SULPHIDE FROM MUD. *J. Soil Sci.* 15(1): 103-109. 1964.

Damage due to H_2S occurring in some acidic, heavy paddy soils, and peaty fish-ponds is usually preceded by falls in temperature and atmospheric pressure. The O_2 content of the water layer increases with the fall in the temperature and, as the redox-level sinks in the mud, the superficial layer of the mud is oxidized and H_2SO_4 is formed which releases H_2S from the sulphide in its environment. The decrease of atmospheric pressure lifts the gases including H_2S from the hallows of the mud into the water layer and thence into the atmosphere. The gases carry colloidal particles and render the water turbid. The released H_2S may result in root-rot and deficiency diseases in the rice plants, and algae bloom and fish death in the ponds.

Inst. for Plant Physiology, U. Szeged, Szeged, Hungary.

73. Gallagher, P. A., and Herlihy, M. AN EVALUATION OF ERRORS ASSOCIATED WITH SOIL TESTING. *Irish J. Agr. Res.* 2(2): 149-167. 1963.

Sixty spot samples were taken from five selected fields at approximately monthly intervals over a period of a year. Mean values for K, particularly in grassland soils, varied widely over the experimental period. Soil pH values also varied in some fields, indicating that the interpretative values of soil K and pH were subjective in terms of time of sampling. Time of sampling also influenced pH and P evaluation in soils recently limed and treated with phosphatic fertilizer, respectively.

Soil sampling errors, except for K, were higher on soils recently limed and manured. However, soil sampling errors for pH in untreated grassland soils were generally high in relation to limed areas. Sampling errors for soil K were independent of treatment used but appeared to be influenced by a seasonal fluctuation in K status of soils. In general, sampling error for K was higher in grassland soils. Analytical error for pH, Ca, and P were important when sampling errors were low. Confidence intervals were computed for pH, Ca, P, and K from which two, or at most three, categories of available nutrients (low, medium, high) were suggested for crops segregated on the basis of nutrient requirements.

An Foras Taluntais (The Agricultural Institute) Soils Div., Johnstown Castle Agr. Col., Wexford, Ireland.

74. Brogan, J. C., Coulter, B. S., and Kelly, O. D. THE PREPARATION OF SOIL SAMPLES FOR ANALYSIS: A COMPARISON OF WETTING AND DRYING. Irish J. Agr. Res. 2(2): 125-130. 1963.

Soil samples are normally prepared for analysis by air drying and sieving. An alternative method, mixing with water to form a slurry and taking an aliquot with a syringe, was described.

Experiments were carried out on 37 Irish soils to compare the methods. The authors concluded that:

1. There were important differences in the results obtained by the two methods. These could be due to chemical changes on drying or differences in the amount of soil taken by the two aliquots. On the average, the 8 ml. volume of the slurry corresponded to 6.3 ml. of dry soil but with heavy clay soils the wet aliquot was smaller and with light sandy soils the wet aliquot was larger. Correcting the results for aliquot size did not alter the conclusions drawn from the experiments, as in many cases the differences between methods was increased rather than diminished. Magnesium, for example, was higher in the wet method for nearly all soil types. Calcium in one soil (an organic silt loam derived from coal measure shale) was nine times higher for the dry method than for the wet method (2,600 p.p.m. and 300 p.p.m.), and in the same soil, phosphorus was twice as high for the dry method (2.8 p.p.m. versus 1.3 p.p.m.). The pH value was relatively insensitive to changes in aliquot size, thus the pH of soil suspensions having soil water ratios of 1:2 and 1:5 only differed by 0.1. An average pH difference of 0.3 was recorded between the two methods in the second experiment.
2. It was concluded that the differences between methods with pH, phosphorus, and magnesium were due to chemical changes occurring in the soil on drying. This being the case, the wet method of preparation was preferred as it more closely represented the field conditions.
3. It was proposed to introduce the wet preparation method as standard procedure in the analysis of all advisory samples at this laboratory.
4. The wet method of preparation was quick, it used all the sample, it avoided contamination between samples, and it was not subject to chemical change before analysis. It was, therefore, superior to the current method of soil sample preparation.

An Foras Taluntais (The Agricultural Institute) Soils Div., Johnstown Castle Agr. Col., Wexford, Ireland.

75. Porter, L. K., Stewart, B. A., and Haas, H. J. EFFECTS OF LONG-TIME CROPPING ON HYDROLYZABLE ORGANIC NITROGEN FRACTIONS IN SOME GREAT PLAINS SOILS. Soil Sci. Soc. Amer. Proc. 28(3): 368-370. 1964.

Virgin soils and their long-time cropped counterparts were hydrolyzed with HCl. The N was separated into three fractions. The proportion of N that each N fraction contributed to the total N was altered when comparisons were made between virgin soils and their cropped counterparts. Cultivation and cropping caused losses in all three N fractions, however, the nondistillable acid-soluble N fraction lost a greater proportion of its N than did the other two fractions.

SWCRD, ARS, USDA, Fort Collins, Colo., 80522

76. Chao, T., and Kroontje, W. RELATIONSHIPS BETWEEN AMMONIA VOLATILIZATION, AMMONIA CONCENTRATION AND WATER EVAPORATION. Soil Sci. Soc. Amer. Proc. 28(3): 393-395. 1964.

The rate of NH_3 volatilization and the rate of water evaporation from soils followed different functions. These functions were not affected by differences in soil texture, soil water, speed, or relative humidity of air flowing over the soil surface. A linear relationship was observed between the rate of NH_3 applied (up to 600 p.p.m.) and NH_3 volatilized. The NH_3 losses from finer textured soils were proportional to their original soil pH's. The larger NH_3 losses from the coarse textured soil indicated that soil texture was a key factor in NH_3 volatilization.

Fayetteville State Col., Fayetteville, N.C.

77. Page, A. L., and Ganje, T. J. THE EFFECT OF pH ON POTASSIUM FIXED BY AN IRREVERSIBLE ADSORPTION PROCESS. Soil Sci. Soc. Amer. Proc. 28(2): 199-202. 1964.

The irreversible adsorption of K by soils, vermicultie, and illite under moist conditions was studied over a range of pH 3 to 8. The amounts of K irreversibly adsorbed by the vermicultie and soils that contained biotite-weathering products were independent of the soil- or clay-solution equilibrium pH as long as the concentration of Al in the systems was kept low. The results were interpreted to indicate that K, which is fixed by irreversible adsorption, is associated only with the permanent charge component of the exchange complex.

Acid-leaching the soils destroyed their capacity to irreversibly adsorb K from KCl solution at pH 3 and markedly reduced their exchange capacities at the same pH. The acid-leached soils contained relatively large concentrations of base-titratable Al, which were nonreplaceable with either 1.0 N NaCl or 1.0 N KCL. Therefore, the results indicate that difficultly replaceable Al on the exchange sites of the acid-leached soils prevented the adsorption of K on sites which were capable of irreversibly adsorbing it.

U. Calif., Citrus Res. Cent. and Agr. Expt. Sta., Riverside, Calif.

78. Malo, B. A., and Purvis, E. R. SOIL ABSORPTION OF ATMOSPHERIC AMMONIA. Soil Sci. 97(4): 242-247. 1964.

The NH_3 content of the atmosphere in New Jersey varied from a trace to 0.22 mg./m.³, and to average 0.057 mg./m.³, in weekly determination made over a 12-month period. The average concentration was approximately three times that accepted as normal.

The NH₃-N content of precipitation at New Brunswick averaged 92 g. per acre-inch, and totalled 8.2 pounds of N per acre, over a 12-month period.

Soil adsorption of NH₃ from the atmosphere was demonstrated in field, greenhouse, and gas chamber studies. Rates of absorption varied with soil type and ranged from approximately 23 to 91 g. of NH₃-N per acre per day under field conditions. Nitrogen from this source is believed to have been a factor in the production of high corn yields without nitrogen fertilization in several New Jersey field trials from 1958-60.

N.J. Agr. Expt. Sta., Rutgers, The State U. N.J., New Brunswick, N.J.

79. Mullin, R. E. ACIDIFICATION OF A FOREST TREE NURSERY SOIL. Soil Sci. Soc. Amer. Proc. 28(3): 441-444. 1964.

Artificial acidification of nursery soils for coniferous seedling production is being studied on soils which have become alkaline through continuous use. Three methods of acidification are being examined, acidification of the irrigation water, incorporation of acid peat, and incorporation of powdered S. The experimental work is being done on red pine (*Pinus resinosa*, Ait.) seedbeds used for production of 3-0 shipping stock. The experiment is in three sections, starting in consecutive years, each running for 3 years in the nursery, and providing trees for observations in the laboratory and after outplanting.

Acidification of the irrigation water, to pH 6.0 by automatic injection of H₂SO₄ has shown no measurable effect on soil pH or seedlings. Addition of powdered S at 750, 1,500, and 2,250 lb./A. has been most effective. The soil pH has been reduced proportionately, with that of the heaviest treatment to about pH 5.0, with some fluctuation, and the effect has not diminished after more than 3 years. The S treatment of 2,250 pounds caused mortality in the seedbeds, whereas the lesser treatments caused an increase in survival. Sulphur addition also resulted in taller, thicker, heavier seedlings with the first level causing a large increase, the second a minor (plateau effect), and the high level a large increase again.

Ontario Dept. Lands and Forests, Res. Br., Maple, Ontario, Canada.

Soil Biology

SEE ALSO 43, 54, 75, 76, 139, 152, 159, 160.

80. Schnitzer, M., and Gupta, U. C. SOME CHEMICAL CHARACTERISTICS OF THE ORGANIC MATTER EXTRACTED FROM THE O AND B₂ HORIZONS OF A GRAY WOODED SOIL. Soil Sci. Soc. Amer. Proc. 28(3): 374-377. 1964.

Organic matter extracted from the O and B₂ horizons of a Gray Wooded soil was characterized by ultimate and functional group analyses and by infrared spectroscopy. The analytical data were compared with those obtained by the use of the same methods on Podzol O and B_h organic matter.

Gray Wooded humic and fulvic acids were chemically similar to Podzol humic and fulvic acids except that Gray Wooded organic matter contained more phenolic hydroxyl groups. In analogy with Podzols, approximately 70 percent of the organic matter extracted from the Gray Wooded O horizon was humic acid, while 90 percent of the extract from the B₂ horizon consisted of fulvic acid.

Gray Wooded organic matter was difficult to extract and purify because of intimate association with clay and possibly other inorganic constituents.

Soil Res. Inst. Res. Br., Canada Dept. Agr., Ottawa, Canada.

81. Schreven, D. A. Van. A COMPARISON BETWEEN THE EFFECT OF FRESH AND DRIED ORGANIC MATERIALS ADDED TO SOIL ON CARBON AND NITROGEN MINERALIZATION. *Plant and Soil* 20(2): 149-165. 1964.

Incubation experiments were carried out at 29° C. in which fresh chopped, dried chopped, or dried and ground material of wheat plants, Polygonum nodosum, Senecio congestus (R. Br. DC.) and lucerne were mixed with a heavy calcareous loam. The C/N ratios of these materials were 45.9, 32.0, 19.3, and 12.6, respectively. At intervals of 1 or 2 weeks, the content of mineral nitrogen in the treated and untreated soils was determined to calculate the immobilized or released nitrogen. The production of CO₂ in the soils treated in the same way was determined in a parallel experiment.

The mineralization of the carbon and nitrogen of incorporated organic materials was influenced not only by the N-content, the C/N ratio of the materials, and the amount of the materials, but also depended on whether the plant materials were fresh chopped, dried chopped, or in a dried and ground condition.

In most cases, a retardation of the rate of nitrogen mineralization was found after drying the organic materials due to an increase of the C/N ratio of the water-soluble organic fraction by drying. The depressing effect of drying on the rate of nitrogen mineralization was increased by a mechanical breaking-up of the dried materials, presumably due to an increased surface of the non-soluble carbonaceous compounds.

Microbiological Lab., Ysselmeer Polders Develop. and Settlement Authority, Kampen, Netherlands.

82. Bowen, H. J. M., and Cawse, P. A. EFFECTS OF IONIZING RADIATION ON SOILS AND SUBSEQUENT CROP GROWTH. *Soil Sci.* 97(4): 252-259. 1964.

Two soils were treated with ionizing radiation at a range of doses from 0.001 to 60 megarads. Most physical and chemical properties measured subsequently showed little change, apart from the exchangeable nitrogen, which increased markedly, and the rate of loss of water, which decreased slightly.

Evidence was obtained that supported the hypothesis that the extra nitrogen appears primarily as ammonia, which is microbiologically oxidized to nitrate if the soils have not been sterilized. It arises from nitrogen immobilized in soil organic matter in the following ways: (1) Rapidly, by radiation decomposition; (2) more slowly, by the action of enzymes such as urease, which are resistant to radiation; and (3) by microbial action. The last two modes of production can be inhibited by boiling the soils in ethanol, or by irradiating and incubating under dry conditions.

Growth of lettuce and barley was consistently stimulated in soils which had received 0.02 to 2 megarads, and under suitable conditions after 0.005 megarads. The stimulation was believed to be caused mainly by the increase in available nitrogen.

Atomic Energy Auth., Wantage Res. Lab., Wantage, Berks, England.

83. Cummins, D. G., and McCreery, R. A. THE EFFECT OF GAMMA AND NEUTRON IRRADIATION OF SOIL ON THE YIELD AND NUTRIENT UPTAKE OF RYE. *Soil Sci. Soc. Amer. Proc.* 28(3): 390-393. 1964.

Cecil s1 and Lakeland s with six fertility treatments, at field capacity and air dry, were subjected to three rates of mixed gamma and neutron radiation from an air-shielded 10 megawatts thermal reactor. Rye was grown as a test crop on these soils in the greenhouse. Forage yield and uptake of N, P, K, Ca, Mg, and Na by rye were used to evaluate irradiation effects. Yields of rye on Cecil soil were increased as a result of irradiation when N was limiting, probably as a result of increased mineral N

from dead organisms. The uptake of P, K, Ca, Mg, and Na was not affected by irradiation, except where influenced by an increased yield due to N. Soil moisture at irradiation time did not influence irradiation effects on rye yields.

Ga. Expt. Sta., Experiment, Ga.

84. Wollum, A. G., II., and Youngberg, C. T. THE INFLUENCE OF NITROGEN FIXATION BY NONLEGUMINOUS WOODY PLANTS ON THE GROWTH OF PINE SEEDLINGS. J. Forestry 62(5): 316-321. 1964.

Nodulated seedlings of snowbrush (Ceanothus velutinus dougl.) and red alder (Alnus rubra Bong.) were grown in low nitrogen content soils in the greenhouse. Pumice and granitic subsoils were used for snowbrush and alder respectively. After 9 months, the seedlings tops were removed by clipping at the groundline. Monterey pine (Pinus radiata D. Don) was seeded to the pots following removal of the snowbrush and alder seedlings and to pots of fresh soil that received the following levels of nitrogen: 0, 25, 50, 75, and 100 p.p.m. All treatments also received 100 p.p.m. of P. After 12 months, the pine seedlings were harvested, weighed to obtain yield data, and analyzed for nitrogen. The yield and nitrogen content of the pine seedlings was comparable to 35 p.p.m. added nitrogen for seedlings grown after snowbrush seedlings and 15 p.p.m. for those grown after alder seedlings.

The influence of snowbrush, ponderosa pine (Pinus ponderosa Laws.), alder, and Douglas-fir (Pseudotsuga menziesii [Mirb.] Franco) litters on the growth of Monterey pine was also investigated. Douglas-fir litters at the rate of 200 grams per 2,500 grams of granitic subsoil had a depressing effect upon the growth of Monterey pine, whereas alder litter had a beneficial effect. Ponderosa pine and snowbrush litter both had beneficial effects on the growth of Monterey pine. The nitrogen content of seedlings grown with added alder and snowbrush litter was higher than those grown with added nitrogen.

Oreg. State U., Corvallis, Oreg.

85. Adams, R. S., Jr., and Stevenson, F. J. AMMONIUM SORPTION AND RELEASE FROM ROCKS AND MINERALS. Soil Sci. Soc. Amer. Proc. 28(3): 345-351. 1964.

Some igneous rocks and primary silicate minerals were found to retain added NH_4^+ against extraction with 1.0 N KCl. The amounts ranged from 15 to 244 p.p.m., and were 3 to 15 times the quantity of NH_4^+ in the original rock or mineral. At least two types of reactions were involved, namely, sorption at particle surface and intra-particle penetration. In contrast to the NH_4^+ held in difficultly exchangeable forms by soils and secondary silicate (clay) minerals, part of the nonexchangeable NH_4^+ in rocks and primary silicate minerals was released readily with hot 1.0 N KOH. The micas were primarily responsible for NH_4^+ fixation by igneous rocks.

U. Minn., St. Paul, Minn.

86. Brown, M. E., Burlingham, S. K., and Jackson, R. M. STUDIES ON AZOTOBACTER SPECIES IN SOIL: III. EFFECTS OF ARTIFICIAL INOCULATION ON CROP YIELDS. Plant and Soil 20(2): 194-214. 1964.

The effects of plant growth on inoculating seeds, roots, or soil with Azotobacter cultures were examined in pot and field experiments designed for statistical analysis. Only those plants inoculated with live untreated cultures showed any significant growth responses. In pot experiments, crop yield showed an average increase in weight of 11 percent, leaf weights were increased by 8 percent, and root weights by 0.5

percent. Significant effects were closely correlated with plant health. Azotobacter inoculation in soil expected to carry unhealthy plants, gave plants that immediately grew better than controls. In soil infected with Ophiobolus graminis, this improvement was not because root disease was prevented.

Field experiments with healthy crops produced only two significant increases in yield and possible reasons for lack of effects were examined. The primary cause was failure to establish the Azotobacter inoculum in the rhizosphere.

Factors that might influence effects of inoculation were examined in pot experiments. These were, addition of mineral fertilizers or carbohydrates to the soil, the soil moisture content, the size and age of the Azotobacter inoculum used — particularly when it applied to seeds, and the strain of Azotobacter. None of these factors were important.

Rothamsted Expt. Sta., Harpenden, Hertfordshire, England.

87. Hannapel, R. J., Fuller, W. H., and Fox, R. H. PHOSPHORUS MOVEMENT IN A CALCAREOUS SOIL: II. SOIL MICROBIAL ACTIVITY AND ORGANIC PHOSPHORUS MOVEMENT. *Soil Sci.* 97(6): 421-427. 1964.

The role of soil microorganisms in the movement of phosphorus in a calcareous soil was assessed. The addition of a microbial energy source increased the movement of phosphorus by about 38-fold, with more than 95 percent of the phosphorus moving being organic. Treatment with formaldehyde suppressed the activity of the microbial population and reduced phosphorus movement. Millipore filtration (0.45 μ pore size) indicated a large portion of the organic phosphorus to be associated with microbial cells and cellular debris. The possibility that a large fraction of the organic phosphorus in the soil solution is colloidal in nature was discussed with respect to the demonstrated inability of higher plant roots to utilize the organic phosphorus found in the soil solution.

Agr. Expt. Sta., U. Ariz., Tucson, Ariz.

88. Shields, L. M., and Durrell, L. W. ALGAE IN RELATION TO SOIL FERTILITY. *Bot. Rev.* 30(1): 92-128. 1964.

The significance of soil algae to synthesize carbon and fix nitrogen was studied. Investigations were reviewed that was concerned with: (1) The role of soil algae; (2) factors governing growth and distribution; (3) floristic composition; and (4) culture of soil forms.

Soil algae have been evaluated as: (1) Colonizers of unfavorable substrate; (2) the initial stage in succession on denuded sites; and (3) a water-conserving stratum in semi-desert habitats.

Blue-green algae are among the first organisms to develop on volcanic and other rock substrates. Algae consolidate the soil surface, leading to crust formation, particularly in areas denuded by macrovegetation by drought or erosion. The interwoven growth of such blue-green genera as Porphyrosiphon, Microcoleus, Plectonema, Schizothrix, and Scytonema stabilizes a non-erosible surface layer which breaks the force of falling water, improves infiltration, and affords a substrate upon which seeds and spores germinate. Soil moisture averaged 8.9 percent for alga-stabilized surface crust compared to 1.3 percent for bare soil in the same fields. During a period of quick desiccation, many algal cells die, but none of the species represented is likely to disappear entirely. With continued desiccation, the population remains fairly constant for several years. Numbers vary in relation to weather conditions as light, drought, frost, and snow, but seasonal succession of species rarely occurs.

Soil algae were assessed from the standpoint of nitrogen nutrition in desert, semi-desert soils, and in rice fields. A number of terrestrial forms are among the genera of Cyanophyceae for which nitrogen fixation has been established: Nostoc, Anabaena, Cylindrospermum, Aulosira, Tolypothrix, Calothrix, Anabaenopsis, Mastigocladus, and Coccochloris.

The nitrogen content of semi-desert soils increased 400 percent where algal growth was extensive. In an internal drainage basin in New Mexico, Kjeldahl nitrogen averaged 1031 p.p.m. for alga-stabilized soil crusts, 1553 p.p.m. for lichen crusts, and 225 p.p.m. for surface strata in the absence of an algal or lichen flora. Rice plants can grow with no nitrogen other than that fixed from the air by the associated soil alga. The nitrogen compounds formed by algal cells are released into the surrounding substrate either during life or upon death and decomposition. These are mineralized when moisture becomes available and are distributed with soil water. A surface growth of algae thus represents a continuous supply of soil nitrogen.

The factors most influential in determining the growth and distribution of soil algae are: (1) The substrate; (2) pH; (3) water requirement; and (4) depth in the soil.

The chemical nature of the substrate appears to be less significant than physical properties in determining the soil algal population. Where water is not a limiting factor, soil nutrient tends to govern the luxuriance of the algal flora and the number of species represented. Firmness of the surface may influence the development of a diatom population or a surface crust stabilized by Cyanophyceae, algal distribution tending to be wider on clay than in lighter soils. Algal growth on rock is influenced primarily by hardness of the substrate and insolation, both factors relating to the water supply. The species on siliceous and calcareous rocks may differ, however, and certain species are typically of the under side of quartz and other types of rock which transmit light.

Most algae tolerate a wide range in pH. Algal populations are greatest, however, on moderately acid or alkaline soils, and the dominant species are often quite different on acid and alkaline substrates. On acid soil (pH 3.7 to 4.8), the characteristic algae are primarily genera of Chlorophyceae: Coccomyxa, Euglena, Gloeocystis, and Mesotaenium, while certain species of Hormidium, Dactylococcus, Cylindrocystis, and Prasiola are common in less acid environments. Cyanophyceae are not characteristic of acid soils. The filamentous blue-green algal species of arid southwestern soils are adapted to an alkaline substrate. Calcium carbonate applied to paddy soil stimulates algal growth and nitrogen fixation through shifting the pH toward the alkaline range. Above 5.7, however, iron is likely to be precipitated in culture.

Separation of the effect of pH and of moisture level on soil algae is complicated by the almost universal alkalinity of arid, unleached substrates, and the acidity of wet soil. Moisture, not pH, however, determines the predominance in arid soils of certain Cyanophyceae: Microcoleus, Schizothrix, Scytonema, Protosiphon, Porphyrosiphon, and Plectonema, which resist desiccation through physiologic properties of the photoplasm or the presence of an enclosing sheath. In contrast, certain species of Chlorococcum, Cystococcus, Pleurococcus, Hormidium, and other genera are characteristic of wet, acid substrates. Mixed populations of Chlorophyceae, Cyanophyceae, and diatoms survived desiccation in dry soil 26 to 73 years. Nostoc commune from an herbarium sheet grew in culture after 87 years as a dried specimen.

All algal growth occurs within the top few millimeters of the soil, subsurface algae being carried down largely by the action of natural agencies, but not multiplying to any appreciable extent after burial.

Bibliography of 182 references.

N. Mex. Highlands U., Las Vegas, N. Mex.

Soil Plant-Animal Relationships

SEE ALSO 61, 62, 71, 79, 82, 83, 84, 146, 148, 150, 159, 160, 161, 162, 165, 167, 173, 174, 183, 196, 217.

89. Boawn, L. C., and Leggett, G. E. PHOSPHORUS AND ZINC CONCENTRATIONS IN RUSSET BURBANK POTATO TISSUES IN RELATION TO DEVELOPMENT OF ZINC DEFICIENCY SYMPTOMS. *Soil Sci. Soc. Amer. Proc.* 28(2): 229-232. 1964.

Russet Burbank potatoes were grown on field plots and in nutrient solutions at levels of Zn and P nutrition that would produce plants ranging from no Zn deficiency to severe Zn deficiency.

Increasing the supply of P induced a growth disorder that could be eliminated by an increased supply of Zn. Neither the development of the deficiency nor the elimination of the deficiency was well correlated with changes in the concentration of Zn in stem and leaf tissues. High concentrations of P in tissues resulting in high P/Zn concentration ratios appear to offer a better explanation for the metabolic upset. Healthy plants tended to have P/Zn concentration ratios < 400, whereas in deficient plants the ratio was generally > 400.

The data indicated a mutual antagonism between P and Zn in their uptake and accumulation in the plant.

SWCRD, ARS, USDA, Prosser, Wash., 99350

90. Rosell, R. A., and Ulrich, A. CRITICAL ZINC CONCENTRATIONS AND LEAF MINERALS OF SUGAR BEET PLANTS. *Soil Sci.* 97(3): 152-167. Mar. 1964.

Sugar beet plants at the cotyledonous stage of development were transplanted from Zn-free conditions to a series of 10 nutrient solutions provided stepwise with 0 to 200 µg. of Zn per liter of solution. Nutrient salts were purified relative to Zn when necessary, and all-glass redistilled water was used as required.

The plants were harvested when those in the six lowest treatments showed Zn-deficiency symptoms. The tops were separated into immature, mature, and old leaves, and these were further subdivided into petioles and blades. The petioles and blades were analyzed for Zn, Fe, Mn, Na, K, Ca, Mg, nitrate-N, phosphate-P, total P, and sulfate-S, and the storage roots for sucrose content.

The tissues most suitable for assessing the Zn status of sugar beets were the blades from mature and old leaves, but, because of less contamination under field conditions, the blades of recently matured leaves, rather than those of old leaves, were recommended for Zn analysis. The critical Zn concentration was approximatley 8 to 10 p.p.m. for oven-dried mature blades.

The Zn concentrations in the petioles varied in a unique manner and did not provide a well-correlated yield-concentration curve. Visual symptoms of Zn deficiency are unique and can be used as a preliminary guide in assessing the Zn status of sugar beet plants.

The concentrations of Fe and Mn in mature blades, and of nitrate and phosphate in mature petioles and blades, were much higher in plants deficient in Zn than in non-deficient plants. High nitrate and phosphate accumulation in the blades of Zn-deficient plants suggested that Zn was necessary in nitrate reduction and phosphate utilization either directly or indirectly or in the formation of enzymes necessary to the metabolism of nitrate and phosphate. Sulfate-S accumulated to a much smaller extent in the mature blades of Zn-deficient plants than either nitrate or phosphate. The sums of the cations of the macronutrient and micronutrient elements in the mature blades increased with Zn deficiency.

Zn-deficient sugar beet plants had a lower root and top weight, and in extreme deficiency, a lower sucrose concentration.

U. Calif., Berkeley, Calif.

91. Hylton, L. O., Jr., Williams, D. E., Ulrich, A., and Cornelius, D. R. CRITICAL NITRATE LEVELS FOR GROWTH OF ITALIAN RYEGRASS. *Crop. Sci.* 4(1): 16-19. 1964.

Italian ryegrass was grown in the greenhouse in a series of nutrient culture solutions adequate to inadequate in N. All plants were harvested at the late vegetative stage of growth when they showed a definite gradation in symptoms from severe to no deficiency of N. The plants were separated into six parts, dried, weighed, and ground for chemical analysis. Oven-dry weights of tops were plotted against nitrate-N concentrations in specific plant parts to give calibration curves. Blade 1 (youngest fully open leaf with a ligule) was selected as the best tissue to indicate the N status in the plant from a comparison of the curves for blades 1, 2, and 3, stem, and tiller. A nitrate-N value of 1,000 p.p.m. or less in blade 1 was estimated as the critical-N value and was indicative of a N deficiency in Italian ryegrass.

CRD, ARS, USDA, U. Calif., Berkeley, Calif.

92. Rios, M. A., and Pearson, R. W. THE EFFECT OF SOME CHEMICAL ENVIRONMENTAL FACTORS ON COTTON ROOT BEHAVIOR. *Soil Sci. Soc. Amer. Proc.* 28(2): 232-235. 1964.

A vertical split-root technique was described that permitted the measurement of effects of various ions in the subsurface zone on root development. The surface zone consisted of an adequately limed and fertilized sandy loam soil.

Cotton roots failed to develop in the lower zone in the absence of Ca, showing that cotton was unable to translocate Ca downward at a rate that would sustain root growth.

Development of cotton roots was not prevented by the absence of P in the rooting medium, showing that the translocation rate of P was adequate to supply these roots from surface soil sources.

Concentrations of soluble Al as low as 1 p.p.m. prevented root growth of cotton seedlings and concentrations of 0.5 p.p.m. greatly reduced root development and caused severe symptoms of toxicity. Even when roots were severely damaged, no effects were observed in the tops. Damage to the subsurface roots by Al was not prevented either by liming and fertilization of the surface soil, or by the presence of adequate Ca in the rooting medium itself.

High concentrations of Mn did not affect root growth directly.

Jr. Author, SWCRD, ARS, USDA, Auburn, Ala., 36830

93. Kubota, J. COBALT CONTENT OF NEW ENGLAND SOILS IN RELATION TO COBALT LEVELS IN FORAGES FOR RUMINANT ANIMALS. *Soil Sci. Soc. Amer. Proc.* 28(2): 246-251. 1964.

The Co content of soils and common forage plants was low and related to reported areas of Co deficiency in ruminant animals in two extensive areas of granitic drift deposits in New England. One of the areas extends from southwestern Maine to southeastern New Hampshire, encompassing an area mantled by granitic drifts from the White Mountains. The other area occurs in southeastern Massachusetts and includes Cape Cod. The low Co soils within these areas are Podzols, Brown Podzolic soils, and Ground-Water Podzols of sand to fine sandy loam textures. These soils have 5 p.p.m. or less Co, and legumes grown in them have 0.07 p.p.m. or less Co.

Similar soils outside of the areas were noted and soils of loam, silt loam, and clay surface textures had sufficient Co to produce legumes with adequate amounts of Co. Grasses with very few exceptions had low amounts of Co irrespective of soil.

SCS, USDA, Ithaca, N.Y.

94. Bradford, G. R., Harding, R. B., and Miller, M. P. SEVERE COPPER DEFICIENCY IN ORCHARD GRAPEFRUIT TREES. *Hilgardia* 35(12): 323-327. 1964.

Symptoms of severe copper deficiency were visually diagnosed in three grapefruit orchards near Hemet, Calif. Typical symptoms of copper deficiency were dieback of young twigs, chlorosis of terminal leaves, and misshapen, rough fruit with brown necrotic spots on the outside and gum pockets in the albedo. Gumming on twigs, a typical symptom of copper deficiency reported from other areas, was not identified.

A possibility of boron deficiency was tested by a randomized block experimental design consisting of four single tree replicates at two separate locations in the orchard. Treatments consisted of 80 grams of borax per tree, borax plus copper spray, and copper spray only. Visual symptoms of copper deficiency were corrected by a copper spray. Copper content of grapefruit leaf samples was generally less than 0.75 p.p.m. and total copper content of virgin soil from the area as low as 1.6 p.p.m. These observations and data emphasize that visual symptoms are initially helpful in diagnosing copper deficiency of citrus in southern California, but a final positive diagnosis depends upon copper analysis of leaf material and soils.

Agr. Pub., U. Hall, U. Calif., Davis, Calif.

95. Chapman, H. L., Jr., and Kidder, R. W. COPPER AND COBALT FOR BEEF CATTLE. Fla. Agr. Expt. Sta. B. 674, 15 pp. 1964.

Results of experiments conducted during the past 10 years at the Everglades Station relating to copper and cobalt requirements of beef cattle were presented. Symptoms of copper and cobalt deficiencies were described, and also symptoms of copper toxicity. Several copper sources were utilized effectively, but copper sulfate was the principal source recommended for furnishing copper to beef cattle. The amount of copper in a mineral mixture should be adjusted to the rate of consumption. A mixture consumed at a rate of 35 to 40 pounds per animal yearly should have a minimum of 0.75 percent copper for cattle on organic soil and 0.15 percent on sandy soil. The extra copper was needed for cattle on organic soil because of the relatively high level of molybdenum present in the soil and in forage grown on this soil.

Mineral mixtures used on either mineral or sandy soils should contain 0.03 percent cobalt. Cobalt is important for vitamin B₁₂ synthesis in the rumen and is involved in the proper utilization of copper.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.

96. Yermanos, D. M., Francois, L. E., and Bernstein, L. SOIL SALINITY EFFECTS ON THE CHEMICAL COMPOSITION OF THE OIL AND THE OIL CONTENT OF SAFFLOWER SEED. *Agron. J.* 56(1): 35-37. 1964.

Four commercial varieties of safflower (N-10, U.S. 10, Gila, and 41191197) were grown under four levels of salinity, and their seed was analyzed to determine the effects of salinity upon the quantity and quality of oil produced.

Separate harvest of primary, secondary, and tertiary heads indicated that in the control plot the three classes of heads contributed unequally to total seed yield. Soil salinity caused a drastic decrease in the proportion of seed contributed by the tertiary heads.

In the control plot, the primary heads in all varieties had the highest hull content and seed weight and the lowest oil content. The reverse was true for the tertiary heads. Soil salinity increased hull content but decreased seed weight and oil content. This decrease was most pronounced in the tertiary heads and least in the primary. As a result, in the high-salt plot the tertiary heads had the lowest oil content and the primary had the highest. In regard to oil production the above varieties ranked as follows in order of decreasing tolerance to salinity: N-10, U.S. 10, 41191197, Gila.

In spite of the earlier maturity caused by soil salinity, the fatty acid composition of the seed oils was not changed.

U. Calif., Davis, Calif.

97. Whitenberg, D. C., and Joham, H. E. CARBOHYDRATE COMPOSITION AND DISTRIBUTION IN COTTON PLANT AS AFFECTED BY SUBSTITUTION OF SODIUM FOR CALCIUM. *Bot. Gazette* 125(1): 56-62. 1964.

Carbohydrate composition and distribution in the cotton plant as affected by the substitution of sodium for calcium were studied. No qualitative effect of sodium upon the carbohydrate composition of cotton plants, either in the presence or absence of calcium was found. In the absence of calcium, sodium had a marked influence upon carbohydrate translocation. Plants receiving sodium but no calcium lived longer and, for a limited time, exhibited a carbohydrate distribution pattern more comparable to that of control plants than did those which received neither calcium nor sodium.

It was suggested that, as a partial substitute for calcium, sodium had a role in maintaining carbohydrate translocation and sodium was able to help maintain minus-calcium cotton plants in a condition conducive to the synthesis of cellular constituents.

N.C. State Col., Raleigh, N.C.

98. Cox, F. R., and Reid, P. H. CALCIUM-BORON NUTRITION AS RELATED TO CONCEALED DAMAGE IN PEANUTS. *Agron. J.* 56: 173-176. 1964.

Two field experiments were conducted on a Eustis ls to study nutritional factors affecting physiological concealed damage in peanuts. Two forms of damage were visually noted, one affecting the cotyledon and the other affecting the plumule. The amount of each form was decreased by applications of calcium and/or boron. Application of calcium from gypsum or hydrated lime was more effective than boron in reducing the percentage plumule damage whereas the application of boron was more effective than calcium in reducing the percentage of cotyledon damage.

There was no interaction between the effect of calcium and boron application on uptake of the nutrient into the plants nor on the amount of reduction in damage. The amount of each form of damage was related more consistently to the concentration of calcium and boron in the kernels than to the levels of these nutrients in the stem tips.

N.C. Agr. Expt. Sta., N.C. State, Raleigh, N.C.

99. Soofi, G. S., and Fuehring, H. D. NUTRITION OF CORN ON A CALCAREOUS SOIL: I. INTERRELATIONSHIPS OF N, P, K, Mg, AND S ON THE GROWTH AND COMPOSITION. Soil Sci. Soc. Amer. Proc. 28(1): 76-79. 1964.

A factorial experiment was carried out with irrigated corn grown on a calcareous soil to determine the effect of N, P, K, Mg, and S, both singly and in combination, on the production of grain and stover, and on the nutrient composition of the leaves. Multiple regression equations in quadratic logarithmic form were developed in order to elaborate the effects.

The soil used was calcareous, inherently fertile, and the first order effect of the nutrients was very small for grain and stover yield. The interaction of Mg and S was significantly positive in effect on grain yield. If application of either Mg or S was high, there was a large positive response to the other, while if application of either Mg or S was low, there was a large negative response to the other. However, for yield of stover the Mg-S interaction was significant and negative or opposite in effect. The contrasting effect between grain and stover yields was further indicated by the interactions between the three anion nutrients, N, P, and S, which were all negative for grain production and all positive for stover production. The interactions of K and Mg on stover production were opposite in effect. The K-S, K-P, and K-N interactions were positive while the Mg-S, Mg-P, and Mg-N interactions were negative; the elemental composition was affected to a considerable extent by various interactions as well as by the first order effects of the elements involved.

Jr. Author, Amer. U. Beirut, Beirut, Lebanon.

100. Fletcher, H. F., and Kurtz, L. T. DIFFERENTIAL EFFECTS OF PHOSPHORUS FERTILITY ON SOYBEAN VARIETIES. Soil Sci. Soc. Amer. Proc. 28(2): 225-228. 1964.

Chief and Lincoln soybeans, previously shown to be tolerant and intolerant, respectively, to very high P levels were grown in the greenhouse in soil admixed with ordinary superphosphate at rates varying from 0 to 4,400 pounds of P per acre. The varieties were similar in P response, dry weight, and mineral composition to around 870 lb./A. of added P. Higher levels of added P were better tolerated by Chief than by Lincoln. At 2,620 lb. or more P/A., marginal browning of the leaves, chlorosis, leaf drop, and severe stunting occurred in the Lincoln variety. In the Chief variety, stunting occurred only at much higher levels of P and the other toxicity symptoms never developed. Number of nodules, but neither size nor appearance, was reduced more on the Lincoln variety than on the Chief at intermediate P levels. At highest levels of P, no nodules were found on either variety. In mineral composition, Lincoln increased more than Chief in percent P and K as the P additions increased. Percent P and percent Si showed a reciprocal relationship in both varieties. No striking differences between varieties were observed in the contents of Fe, Mn, Ca, Mg, and B.

Canada Expt. Farm, Azassiz, British Columbia, Canada.

101. Younts, S. E., and Patterson, R. P. COPPER-LIME INTERACTIONS IN FIELD EXPERIMENTS WITH WHEAT: YIELD AND CHEMICAL COMPOSITION DATA. Agron. J. 56(2): 229-232. 1964.

Two field experiments were conducted on an acid, high organic matter soil to study the effect of copper and lime treatments on wheat response. The 1960-61 experiment involved six copper rates in combination with two lime levels and the 1961-62 experiment included four copper and three lime rates in a complete factorial arrangement. Grain yields were estimated and plant samples were analyzed for certain micronutrients and macronutrients and aluminum.

Liming the soil resulted in a lower copper concentration in plants, particularly where the soil pH was increased above 5.1. The application of copper did not increase copper level in the plant. Copper application up to 5 lb./A. increased manganese concentration, while a 10-pound application lowered the manganese level. Raising the soil pH from 4.7 to 5.3 greatly reduced plant manganese. This effect was most striking at the 5-pound copper rate. Aluminum concentration in plants was lowered by the 5-pound copper treatment but was not affected by the soil pH changes. Concentrations of iron and zinc were unaffected by treatments.

Nitrogen content was higher in plants that did not receive copper. The 10-pound copper treatment resulted in a lower nitrogen percentage than did the 2.5- and 5-pound rates. Potassium content was lowest at the 5-pound copper rate. The phosphorus level in entire young plants and wheat grain was not affected by treatment, but the level in mature straw was increased by copper and lowered by lime.

Grain yields were increased by copper applications up to 5 lb./A. Yield was improved by lime at the 0-pound copper rate in both experiments and tended to be improved at the 2.5-pound copper rate in the 1961-62 experiment. Yield was reduced by lime at the 5-pound copper level and tended to be reduced by lime at higher copper levels in the 1960-61 experiment.

N.C. Agr. Expt. Sta., N.C. State, Raleigh, N.C.

102. Miller, W. J., Adams, W. E., Nussbaumer, R., McCreery, R. A., and Perkins, H. F. ZINC CONTENT OF COASTAL BERMUDAGRASS AS INFLUENCED BY FREQUENCY AND SEASON OF HARVEST, LOCATION, AND LEVEL OF N AND LIME. *Agron. J.* 56(2): 198-201. 1964.

The zinc content of Coastal bermudagrass (*Cynodon dactylon* (L.) Pers.) grown on a Coastal Plain soil was not affected by either frequency of harvest or season of harvest. The percentage of zinc in the forage grown on a Piedmont soil was not affected by lime rates below 7,000 lb./A., but it was reduced when 36,000 pounds of lime per acre was applied. Nitrogen fertilization up to 400 lb./A. had little influence on the zinc content of the Coastal bermudagrass. However, higher levels of N (up to 1,600 pounds) increased the zinc content of the forage on a dry matter basis. There was an inverse relationship content of the forage and soil pH. Zinc content per unit of crude protein was not influenced by nitrogen fertilization. Zinc percentage in the forage was not closely associated with the "acid-extractable" zinc content of the soil. The zinc uptake per clipping increased with an increase in forage yield.

U. Ga., Col. Expt. Sta., Athens, Ga.

103. Vlamis, J., and Williams, D. E. IRON AND MANGANESE RELATIONS IN RICE AND BARLEY. *Plant and Soil* 20(2): 221-231. 1964.

The growth of rice and barley was studied in nutrient solutions with Mn as a variable over the range from 0 to 5 p.p.m. The optimum growth in these solutions was obtained when the Mn-concentration was at 0.1 and 0.2 p.p.m. Below this level, the yields dropped rapidly for both species. At higher levels of Mn the yield of barley fell rapidly while that of rice did not show a significant decrease until the 5 p.p.m. treatment was reached and even then the drop was slight compared to barley.

Severe symptoms of Mn toxicity appeared on the old leaves of barley but only slight symptoms showed on rice. Neither species developed chlorosis. The Mn-content of barley leaves reached a value of 1200 p.p.m., while that of rice went as high as 7000 p.p.m. In the roots, the situation was reversed with barley having 8000 p.p.m. Mn against 5000 for rice.

Starting from zero Mn supplied, the iron content of rice and barley fell rapidly in the low range of Mn but this appeared to be a dilution effect. At the higher range of Mn in solution, the tissue iron leveled off. The level of Fe in rice leaves tended to be roughly double that in barley. Substantial amounts of iron were found in the roots but much of this was visible on the surface, probably in the form of iron oxide.

The results were discussed in the light of recent theory concerning the possible role of Mn in accounting for the inferior growth of rice in drained soils compared to submerged soils.

U. Calif., Berkeley, Calif.

104. Keller, T., and Koch, W. THE EFFECT OF IRON CHELATE FERTILIZATION OF POPLAR UPON CO₂-UPTAKE, LEAF SIZE, AND CONTENT OF LEAF PIGMENTS AND IRON. Plant and Soil 20(1): 116-126. 1964.

Potted poplars (strains marilandica, serotina and Flachslanden of Populuseur-americana) which developed iron-deficiency symptoms (chlorosis of upper leaves, winter die-back of leader, and flushing of lateral buds) were treated with a soil application of iron chelate to study the effect of iron nutrition upon CO₂-uptake, iron and pigment content of leaves, and leaf size of a tree species. Foliar content of each iron, chlorophyl, β-carotene, lutein, and violaxanthin was significantly increased by the treatment. Chlorophyl b proved to be particularly sensitive to iron supply.

CO₂-uptake increased in fertilized and non-fertilized leaves with increasing light up to 40,000 Lux, but fertilized leaves assimilated more CO₂ than non-fertilized leaves, especially at light intensities from 5,000 Lux upwards. The assimilatory number was decreased by the iron application since larger amounts of chlorophyl were present in fertilized leaves. If CO₂-uptake was based upon an area unit basis the fertilizer effect became distinct even at 500 Lux. Thus CO₂-uptake was a quick, valuable measure of fertilizer responses.

In severe cases, iron deficiency affected leaf size and thus indirectly reduced photosynthetic activity. A chelate application during the growing season will not affect the size of leaves already formed but may considerably increase the size of leaves formed subsequent to the treatment.

Eidg. Anstalt, für das forstliche Versuchswesen, Birmensdorf ZH, Switzerland.

105. Francki, R. I. B. STUDIES IN MANURIAL VALUES OF SEAWEEDS: II. EFFECT OF PACHY MENIA HIMANTOPHORA ON MANGANESE RELEASE AND PHYSICAL PROPERTIES OF SOILS. Plant and Soil 20(1): 65-73. 1964.

The effect of applying dry meal of the seaweed Pachymenia himantophora to soil was investigated. The seaweed was found to greatly increase the availability of manganese which became toxic to plant growth on acid soils. The release of manganese appears to be due to altered soil physical conditions causing waterlogging of soils low in calcium.

Waite Agr. Res. Inst., U. Adelaide, South Australia.

106. MacKay, D. C., Chipman, E. W., and Langille, W. M. CROP RESPONSES TO SOME MICRONUTRIENTS AND SODIUM ON SPHAGNUM PEAT SOIL. Soil Sci. Soc. Amer. Proc. 28(1): 101-104. 1964.

Five micronutrients and sodium were applied to a virgin sphagnum peat soil, having an initial pH of 3.5, in a 2⁶ confounded factorial greenhouse experiment. To determine

both immediate and ultimate deficiencies, a sequence of 11 crops were grown with spinach, lettuce, and onions as the indicator crops. Yield data were supplemented by soil and crop analyses.

The greatest effect resulted from molybdenum treatment which produced yield increases over no molybdenum of 67, 42, and 198 percent with the 8th, 10th, and 11th crops, respectively. The onion crop was the most responsive.

Copper had little effect on the first few crops, but with the 3rd application (on the 5th crop) serious toxicity resulted, and persisted until the 10th crop. A 63 percent yield increase from Cu was obtained with the final crop.

A highly significant interaction of Mo X Cu was obtained with the last three crops. Although the overall effect of Cu was negative, not significant, and positive on the three respective crops, the interaction was consistently positive.

Repeated applications of manganese and zinc were toxic with yield depressions occurring on the 5th and persisting until the 11th crop.

Sodium was neither beneficial nor detrimental for any crop. Boron had no detectable effect, but analytical results indicated that impurities added in the lime or fertilizers were sufficient to prevent serious deficiency.

Expt. Farm, Charlottetown, Prince Edward Island, Canada.

107. Case, V. W., Brady, N. C., and Lathwell, D. J. THE INFLUENCE OF SOIL TEMPERATURE AND PHOSPHORUS FERTILIZERS ON DIFFERENT WATER-SOLUBILITIES ON THE YIELD AND PHOSPHORUS UPTAKE BY OATS. *Soil Sci. Soc. Amer. Proc.* 28(3): 409-412. 1964.

The effect of root zone temperatures of 15°, 20°, and 25° C. and P sources having water-solubilities of 1, 25, 50, and 100 percent were evaluated in two greenhouse experiments using oats as a test crop. Oats were grown for 43 days and height, dry weight, and P uptake were determined.

Height response to added P was greatest at 15° C. and least at 25° C. The effects of temperature on height were greatest where no P was applied. There was a marked response in forage yields and in P uptake to increasing amounts of applied P and to increasing soil temperature. Root yields and P uptake, however, were highest at 15° C. and lowest at 25° C. In both tops and roots, the temperature effect was greater at high rates of P than at low rates of P application.

In the winter experiment using ammoniated superphosphates, yields and P uptake by oat forage decreased as the percentage of water-soluble P decreased, except at the lowest percentage of water-soluble P where yield and P uptake were not related to water-solubility of P. In the fall experiment where mixtures of MCP and DCP were used, the source of P had little effect on yield and P uptake.

U. Ill., Urbana, Ill.

108. Jones, M. B. EFFECT OF APPLIED SULFUR ON YIELD AND SULFUR UPTAKE OF VARIOUS CALIFORNIA DRYLAND PASTURE SPECIES. *Agron. J.* 56(2): 235-237. 1964.

A pasture of subclover, rose clover, hardinggrass, and annual grasses produced near maximum response the first year where 40 pounds of S per acre was applied as gypsum; however, the proportion of clover to grass continued to increase as the S rate increased to 80 lb./A. The carry-over effect into the second year from 80 pounds of S was roughly equivalent to 20 pounds of S the first year after application. During the cool winter season, 20 pounds of S per acre produced maximum yields. The higher levels of S were not utilized for increased production until the warmer spring months.

Subclover and hardinggrass had the greatest increase in total S uptake as the rate of S applied increased. The uptake in subclover resulted primarily from a large increase in total yield with a relatively small increase in percent S compared with hardinggrass, which increased relatively little in yield with increasing rates of S.

U. Calif., Hopland Field Sta., Hopland, Calif.

109. Kretschmer, A. E., Jr., and Hayslip, N. C. EVALUATION OF SEVERAL COMBINATIONS OF GRASSES AND WHITE CLOVER ON IMMOKALEE FINE SAND IN SOUTH FLORIDA. Fla. Agr. Expt. Sta. B. 676, 16 pp. 1964.

Yields, dry matter, protein levels, and protein yields of various grass-white clover mixtures were compared on an Immokalee fs in south Florida, and the authors concluded that:

1. Yields for the total of 16 clippings were not statistically different, but the bahiagrass-white clover mixtures produced the least forage during spring. Mixtures of pangolagrass, bermudagrass, or carpetgrass with white clover produced equal yields.
2. Dry matter contents varied from about 16 percent in the spring when clover was predominant to 40 percent when the grass component was predominated.
3. Crude protein percent varied from a low of 5 when no clover was present to 28 when almost no grass was present in the clippings. The average crude protein contents ranged from 12.5 to 14.5 percent for grass varieties.
4. The yields of crude protein were greatest in the spring and early summer and lowest in the late fall and winter. During the spring the crude protein yields for the bahiagrasses-clover mixtures were less than for the other mixtures. Nitrogen recovered in the harvested portions of the mixtures ranged from 112 to 176 lb./A. per year.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.

110. Hyde, R. B., and Morrison, J. W. THE EFFECT OF STORAGE TEMPERATURE ON REDUCING SUGARS, PH, AND PHOSPHORYLASE ENZYME ACTIVITY IN POTATO TUBERS. Amer. Potato J. 41(6): 163-168. 1964.

The influence of storage at 40 and 70° F. on reducing sugars, pH, phosphorylase enzyme activity in potato tubers, and the effect on chipping quality, was investigated. In addition to the expected increase in reducing sugars and decline in ship color during storage at 40° F., the pH decreased markedly and phosphorylase enzyme activity increased. Conditioning at 70° F., and after storage at 40° F., lowered reducing sugars, increased the level of pH, and improved chip color.

Although continuous storage at 70° F. after harvest caused little variation in reducing sugars, pH declined, and phosphorylase activity increased, but both to a lesser extent than occurred at 40° F. Chip color was still good after 4 weeks at 70° F. although slightly poorer than at harvest.

Phosphorylase activity was high in tubers stored at 40° F. and since this enzyme catalyzes the breakdown of starch, it could be a factor influencing sugar accumulation and chip quality. Varieties differed significantly in phosphorylase activity.

The pH of the juice correlated negatively with reducing sugar levels in the tubers and offered an excellent guide for estimating chip quality.

Expt. Farm, Canada Dept. Agr., Morden, Manitoba, Canada.

Soil Classification

SEE ALSO 10, 12, 28, 30, 36, 44, 47, 51, 53, 54, 60, 66, 70, 72, 73, 80, 83, 85, 93, 99, 101, 105, 106, 109, 143, 144, 150, 159, 161, 165, 166, 167, 169, 171, 172, 191, 193, 196, 197, 198, 216, 217, 268, 270, 284, 293.

111. Bailey, L. W., Odell, R. T., and Boggess, W. R. PROPERTIES OF SELECTED SOILS DEVELOPED NEAR THE FOREST-PRAIRIE BORDER IN EAST-CENTRAL ILLINOIS. *Soil Sci. Soc. Amer. Proc.* 28(2): 257-263. 1964.

Two Gray-Brown Podzolic soils and two Gray-Brown Podzolic to Brunizem intergrade (transition) soils which occur near the forest-prairie border in east-central Illinois were studied to determine the effect of vegetation upon soil properties. All four profiles developed in loess and calcareous till of similar age and in the same climatic area so that soil differences are related to length of occupancy by trees, forest composition, and natural drainage.

The Gray-Brown Podzolic soils were more highly weathered and showed more forest influence than the transition soils. This was indicated by higher organic carbon content and base status in the A1 horizons; higher clay maxima, higher cation-exchange capacities, lower Ca/Mg ratios, and lower base status in the B2 horizons; and less organic matter in the lower horizons of the Gray-Brown Podzolic soils than in the transition soils.

The relationships between soil properties and the vegetation sequence in north-central United States were reviewed.

Jr. Author, U. Ill., Urbana, Ill.

112. Brewer, R., and Sleeman, J. R. GLAEBOLES: THEIR DEFINITION, CLASSIFICATION AND INTERPRETATION. *J. Soil Sci.* 15(1): 66-78. 1964.

A broad group of pedological features has been recognized by their occurrence as three-dimensional entities embedded in the matrix of soil materials. They have been named glaebules and are divided into sub-groups on their internal fabric, mineralogy, distinctness as a unit, and shape. These features include nodules, concretions, and septaria which have all been recognized by the petrologist, and pedodes, papules, and glaebular haloes which are newly recognized features. An attempt was made to interpret the origin of these features in terms of processes of formation and inheritance versus formation in situ. This was based on interpretation of the characteristics used for their classification. The author concluded that:

1. Nodules — Nodules rich in soluble fractions of the plasma (e.g. calcite, iron hydroxides) are probably formed by accretion, whereas those with soil or rock fabrics are not. All types of accretionary nodules can be formed in situ (orthic or inherited), but only normal types can be inherited by transport; those with soil or rock fabric are usually inherited (pedo-relicts and litho-relicts) and degree of roundness may distinguish transported types from those formed in situ.
2. Concretions — Most concretions are accretionary. Normal and diffuse types can be formed in situ (orthic or inherited), but only the former are likely to be inherited by transport; inherited types can be litho-relicts or pedo-relicts.
3. Septaria and pedodes — Septaria and pedodes are accretionary, usually formed in situ; septaria may be litho-relicts or pedo-relicts, pedodes may be pedo-relicts.

4. Papules — Papules with continuous fabric can occur as inherited litho-relicts, pedo-relicts, sedimentary relicts, or as disrupted in situ sedimentary relicts; lamellar fabric indicates origin as sedimentary features. Shape may indicate origin. Discoidal shape suggests origin as a sedimentary feature, rounding suggests transport, and angularity suggests disruption of in situ features. The general mineralogy and fabric of papules indicate that they are not accretionary.
5. Glaebular haloes — Glabular haloes are invariably accretionary, formed in situ, and they indicate that the associated, more distinct glaebleus were also formed in situ by accretion.

Commonwealth Sci. and Indrus. Res. Organ., Canberra, Australia.

113. Barker, D. S. THE HALLOWELL GRANITE, SOUTH CENTRAL MAINE. Amer. J. Sci. 262(5): 592-613. 1964.

The Hallowell granite pluton, in the Augusta-Gardiner area, Maine is roughly 10 square miles in area and is elongated parallel to the N. 30 E. trend of fold axes; in detail, contacts are sharply discordant. The surrounding metasedimentary rocks are lower Paleozoic biotite-quartz schists and gneisses, marble, and amphibole-plagioclase-quartz granulite. The pluton was emplaced by forceful and repeated injection of successfully less mafic granites. In the intrusive sequence, biotite content fell from 12 to 2 percent, muscovite increased from 0 to 10 percent, and the plagioclase changed from An₁₅ to An₅. In some outcrops a succession of four distinct granites was recognizable; each new granite stopped angular blocks of its predecessors.

Amounts of biotite and muscovite were variable, but the modal proportions of quartz and feldspars were uniform throughout the pluton and corresponded closely to minimum melting compositions at water pressures of 2,000 to 3,000 bars in the system NaAlSi₃O₈-KAISi₃O₈-SiO₂-H₂O. The two feldspars (now low albite or sodic oligoclase and microperthitic microcline) showed evidence of a complex history of inversion and exsolution since their primary crystallization.

The granites were intruded as magmas which owed their liquid state to high water contents. Crystallization could have occurred mainly by loss of volatiles. Near contacts with marble, granite magma was quenched by the addition of Ca and CO₂, resulting in the crystallization of quartz and plagioclase, without potassium feldspar, biotite or muscovite.

U. Tex., Austin 12, Tex.

114. Kennedy, R. A. THE RELATIONSHIP OF MAXIMUM PEAT DEPTH TO SOME ENVIRONMENTAL FACTORS IN BOGS AND SWAMPS IN MAINE. Maine Agr. Expt. Sta. B. 620, 57 pp. 1964.

Radiocarbon dates of 12 peat samples taken from the bottom layers of peat in 12 Maine bogs in different areas of Maine provided geological information on the approximate rate and direction of ice frontal retreat by melting. The maximum range in the ages was only 1890 years which probably indicates fairly rapid deglaciation of central Maine.

Slope of the adjacent terrain, longitude, and altitude were significantly correlated with maximum peat depth in most of the regression equations. However, none of these variables or their transformations, individually or collectively, account for more than 39 percent of the variation in the maximum depth of peat. The efforts of the airphoto interpreter still require field checking pending further scientific research.

Peat deposits in Maine were classified according to their drainage, altitude, configuration, origin, and development. Field testing will be necessary to determine if this classification system is related to peat depth. Surficial vegetation indicates the present environmental conditions and is not usually related to the depth of the organic substratum. The vegetational complex characterizes the developmental stage of a peat deposit, which, when coupled with information on the origin and hydrologic features, might be related to its thickness.

Maine Agr. Expt. Sta., Orono, Maine.

115. Buol, S. W., and Yesilsoy, M. S. A GENESIS STUDY OF A MOHAVE SANDY LOAM PROFILE. Soil Sci. Soc. Amer. Proc. 28(2): 254-256. 1964.

A Mohave soil profile, representative of Red Desert soils, developed in the Avra Valley in southern Arizona was studied to determine its pedogenesis. A lithologic discontinuity was found at a depth of 60 inches which separated the soil profile from an underlying caliche layer. Only a weak and relatively recent carbonate accumulation was pedogenically associated with the present soil surface. Kaolinite and illite were the predominant clay minerals in the upper layer. Thin sections revealed few clay skins developed in the profile.

U. Ariz., Agr. Expt. Sta., Tucson, Ariz.

116. Jones, R. L., and Beavers, A. H. SOME MINERALOGICAL PROPERTIES OF SEATON, FAYETTE, AND CLINTON SOILS IN ILLINOIS. Ill. Agr. Expt. Sta. B. 701, 27 pp. 1964.

Seaton, Fayette, and Clinton soils constitute a developmental sequence of relatively youthful Gray-Brown Podzolic soils developed in Wisconsin-age loess in the upper Mississippi valley. In Illinois, these soils occur northward along the Mississippi River from its confluence with the Illinois River. Seaton and Fayette soils are developed in loess from 15 to 25 feet thick on Illinoian till in extreme northwest Illinois. Fayette may be developed in loess as thin as 5 feet on till or bedrock. Clinton soils are developed in loess from 8 to 15 feet thick on Illinoian till.

In general, these soils occur in the sequence Seaton, Fayette, and Clinton, with increasing distance from loess source. The median diameter of the loess decreases through this sequence. Structural development is most prominent in Clinton soils. Better internal drainage occurs in Seaton and Fayette soils than in Clinton. The physical and chemical characteristics of these soils were summarized. The authors concluded that:

1. Because of the differences in loess depth between Seaton, Fayette, and Clinton soils, the age of the loess in which these soils are developed probably varies markedly. Using the 22,000 year B. P. date of Fry et al. (1962) for the base of Peoria loess, the Clinton solum has developed in Peoria loess deposited principally from 22,000 to about 11,000 years B. P. A veneer of Recent loess deposited since 11,000 years B. P. is present in the surface. At the Seaton and Fayette sites, the soils are developed in much thicker Recent loess and much younger Peoria loess. The titanium and zirconium analyses and the TiO_2-ZrO_2 ratio indicate that the Peoria loess is fairly uniform in composition below 20 inches to the depth sample for the three soils.
2. Elemental analyses, heavy-mineral analyses, and magnetic susceptibility data indicate that upper portions of the soils of Seaton, Fayette, and Clinton soils of northwestern Illinois are developed in Recent loess.

3. The upper portions of the sola are low in calcium and iron content in the 5 to 20 μ and 20 to 50 μ fractions. This is probably indicative of leaching loss, and possibly a reflection of deposition of a Recent loess blanket poor in these elements. Calcium and iron are also among the first elements to weather in these relatively youthful soils, particularly in the fine-silt fraction. Iron-zirconium and calcium-zirconium ratios suggest similar weathering of these elements. Titanium-zirconium ratios indicate similar proportions of minerals bearing these elements.
4. Heavy-mineral and magnetic susceptibility data indicate a decrease in the heavy-mineral fraction with distance from the bluff or loess source. The forces of grading are invoked to explain this decrease, although progressive weathering through the soil sequence is not entirely discounted. Distribution of plant opal with depth substantiates the depth-distribution pattern; that is, opal is distributed deepest in soils at the bluff. Clay mineral weathering is closely related to internal drainage, and is expressed by progressive formation of a 14A aluminous intergrade mineral derived from montmorillonite upward in the profile. Mica and illite weather to vermiculite throughout the profile.
5. Deposition of Recent loess that is somewhat weathered before deposition complicates interpretation of the mineralogy and weathering of the surficial horizons of these soils. Recognition of this relationship is important, and some of the hypotheses for weathering based on studies in the upper Mississippi Valley and elsewhere may need to be reevaluated in light of it. Contrary to physical appearance, loess need not be uniform in mineralogy either vertically within the section or with distance from source.

U. Ill., Agr. Expt. Sta., Urbana, Ill.

117. Godfrey, C. L. A SUMMARY OF THE SOILS OF THE BLACKLAND PRAIRIES OF TEXAS. Tex. Agr. Expt. Sta. MP-698, 23 pp. 1964.

The Blackland Prairies in central Texas consists of a 9,000,000-acre major prairie plus 2,500,000 acres in two minor prairies for a total of 11,500,000 acres. About 5,500,000 acres of blacklands are the major soil resource. Houston Black, Houston, Austin, Eddy, and Hunt are common soil series. About 4,000,000 acres of graylands consisting of Burleson, Wilson, Crockett, and Bonham soils make up the remaining uplands. Around 2,000,000 acres of bottomlands, or alluvial soils from sediments from the Blackland Prairies, occur in the stream floodplains. Trinity, Frio, Kaufman, and Gowen are the major series. Miller and Norwood are examples of alluvial soils from sediments arising outside the Blackland Prairies which occur to a lesser extent within and near the Blackland Prairies. There are roughly 300,000 acres of these soils.

The soils of the Blackland Prairies have formed in a warm, subhumid to humid climate, under tall grass and sparse hardwood vegetation. The average rainfall ranges from 30 to 44 inches. The soils are derived from weakly consolidated marine and fresh water chalks, marls, limy clays, and clays, silts, and sands of variable lime content, deposited during the Upper Cretaceous and more recent geologic periods.

The blacklands are dark, limy soils, high in montmorillonite clay, which swell on wetting and shrink as they dry, forming soil cracks. Water intake is at a high rate initially when rains fall on soils with such cracks, but runoff increases rapidly as the soil swells and closes the cracks. Erosion is slight to moderate on gently sloping areas but more severe on steeper areas. The blacklands are moderately fertile and are considered more productive than the graylands.

The graylands are lighter colored, more sandy, and acid in the surface soil than the blacklands and have thin surface soils over claypan subsoils. They are drouthy, especially the sloping and eroded soils with thin upper horizons. Where the surface soils are nearly level, the surface soils are thicker and better crop yields are obtained. The greylands are usually lower in cotton root rot infestation than the blacklands but are considered less productive.

The bottomlands have properties similar to the soils which supply the sediments to the floodplain. Wetness, overflow, and slow drainage associated with large quantities of montmorillonite clay make many of these soils difficult to cultivate. The alluvial soils formed from sediments outside the Blackland Prairies contain illitic clays. They are usually higher in silt and sands and better drained and easier to cultivate.

A full-time farmer in the Blackland Prairies usually needs about 250 to 500 acres of productive soils for an economic unit.

Crops grown in the Blackland Prairies usually respond to nitrogen and phosphorus fertilizers but only occasionally to potassium. The extent of response varies with soil types, previous soil management, the kind of crop, and the cropping sequence. Forage and grain crops respond more consistently to higher rates of fertilizers (especially nitrogen) than does cotton.

Crop rotations, weed control, reduction of damage by root rot, diseases, insects, and proper use of fertilizers are key soil management practices. Timing farm operations, good seedbed preparation, and efficient use of soil moisture seem largely to determine the level of benefit derived from soil management. The uniform clay texture of the blacklands and the claypans in the graylands prevent rapid adjustment of the soil moisture and soil air in the root zone of crops. Wet periods and frequent drouths with the accompanying soil crusting and cracking limit the response to soil management.

Supplemental irrigation of crops is obviously needed. But the clayey nature of the soils, the rolling topography, and the lack of ground and surface water have prevented the development of irrigation except for a few small areas.

Tex. A&M U., Tex. Agr. Expt. Sta., College Station, Tex.

118. Grigor'yev, G. I., and Konovalova, A. S. PROBLEMS OF CLASSIFICATION, NOMENCLATURE AND IDENTIFICATION OF CULTIVATED CLAY LOAM SOD-PODZOLIC SOILS OF THE RUSSIAN PLAIN. Soviet Soil Sci. 7: 639-654. July 1963.

A report on the classification, nomenclature, and identification of cultivated clay loam, sod-podzolic soils of Russia were given. The author concluded that:

1. Cultivation of sod-podzolic soils leads to the initiation of a special type of formation composed of a number of elementary processes and having its own stages and forms of development. As a result of removal of forest and radical changes in many processes occurring over the soil profile, the original forest sod-podzolic soils are altered so strongly that they must be placed in a special group which retains, however, its zonal character.
2. Cultivation of sod-podzolic soils leads to the formation of cultivated sod-podzolic soils through three phases (stages) — slightly cultivated, moderately cultivated, and strongly cultivated soils — which can be designated as subgroups.
3. The division of sod-podzolic soils into different stages of cultivation is based on a number of diagnostic indexes (content of exchangeable bases, degree of base saturation, makeup of the humic structure in the A_1 horizon, content of available forms of K and P, etc.) and has great practical importance for the use and rating of land.

4. The rate and forms of development of the state of cultivation as a whole and their component elementary processes depend on generic (related to the soil forming parent materials) and provincial characteristics of the original sod-podzolic soils.
5. Cultivated soils, which are genetically related to natural (virgin) soils, can and should be introduced into the general classification scheme.

Scripto Technica Inc., 1000 Vermond Ave., N.W., Washington, D.C., 20005

119. Bidwell, O. W., and Hole, F. D. AN EXPERIMENT IN THE NUMERICAL CLASSIFICATION OF SOME KANSAS SOILS. *Soil Sci. Soc. Amer. Proc.* 28(2): 263-268. 1964.

Thirty soil characteristics were used to calculate numerical indices of similarity for 29 Kansas soils. The indices varied from 90 for Ladysmith and Irwin soils (100 = perfect similarity) to 34 for Bates and Colby. In general, the numerical classification substantiated the present classification and the concepts of these soils and their interrelationships.

This experiment suggests that the numerical classification of soils, like that of plants, animals, and insects, is possible. The necessary information for this kind of analysis is available for many of our soils. The major obstacle appears to be the selection and weighing, if any, of the characteristics to be considered. Once the characteristics are selected, the determination of numerical relationships is objective and repetitive.

Kans. Agr. Expt. Sta., Kans. State U., Manhattan, Kans.

EROSION CONTROL

Erosion Equation

120. Stamey, W. L., and Smith, R. M. A CONSERVATION DEFINITION OF EROSION TOLERANCE. *Soil Sci.* 97(3): 183-186. Mar. 1964.

A mathematical expression was developed that appears to express the concepts involved in such terms as "soil erosion tolerance" ("permissible soil loss") and "soil renewal."

This expression provides for the use of soil property reserves and the permanent protection or improvement of soil resources in accordance with measurable standards. Net change from present condition is stated by a definite integral involving soil erosion and soil renewal (or addition) rates with time. The basic equation applies to any point on the land surface but can be expanded over a region. Both wind and water erosion are considered, as well as selective and nonselective erosion, and controlled or uncontrolled influences.

The equation clarifies concepts of erosion and renewal, points out prime needs for experimentation, and suggests feasibility of certain types of solutions. Information needed for solution is: (1) Specific inventory of present soil resources; (2) expression of essential soil-property requirements for the future; (3) data on erosion (or wearing away) of soil properties with time; and (4) data on renewal (or additions) to soil properties with time. Choice of a particular solution will depend upon economic influences, personal preference, and public policy.

Jr. Author, Kans. State U., Manhattan, Kans., 66504

121. Smith, R. M., and Stamey, W. L. HOW TO ESTABLISH EROSION TOLERANCES. J. Soil and Water Conserv. 19(3): 110-111. 1964.

The premise that a certain level of soil erosion control is a desirable goal for individuals and for society has generally been accepted. However, there is not general agreement on the precise level of soil loss regarded as tolerable. Because rates of erosion that do not jeopardize soil productivity may vary greatly for different soils, the imposition of fixed soil-loss limits applicable to all soils alike appears unreasonable. A well-defined procedure for establishing practical erosion tolerance standards for any soil was given.

SWCRD, ARS, USDA, Manhattan, Kans., 66504

Wind and Water Erosion

SEE ALSO 37, 138.

Soil Conserv. 29(7): 147-168. 1964.

The February issue of Soil Conservation was devoted to articles on wind erosion control. The following list presents the author, title, and address of each article.

122. Luker, C. GREAT PLAINS PROFITS IN '60's FROM "DUST BOWL" OF THE '30's. SCS, USDA, Washington, D. C., 20005

123. Krohn, J. A., and Johnson, V. E. METROPOLITAN EAST HAS WIND EROSION TOO. SCS, USDA, Mays Landing, N.J.

124. Woodruff, N. P. WIND EROSION LABORATORY FINDS ANSWERS. SWCRD, ARS, USDA, Manhattan, Kans., 66504

125. Weimer, E. R. FARMERS AND CONSERVATIONISTS APPLY RESEARCH FINDINGS. SCS, USDA, Bismarck, N. Dak.

126. Allred, W. M. IN WESTERN MICHIGAN — IT'S AN ILL WIND THAT BLOWS NO GOOD. SCS, USDA, Grand Haven, Mich.

127. Allen, W. S. SOUTHEAST BORROWS FROM WEST TO FIGHT OWN WIND EROSION. SCS, USDA, Spartanburg, S.C.

128. Ferber, A. E. "WHAT HAPPENED TO THE SHELTERBELT?" SCS, USDA, Denver, Colo.

129. Snustad, N., and Tvedten, H. A. COVER CROPS LICK WIND EROSION FOR RED RIVER VALLEY FARMERS. SCS, USDA, Fergus Falls, Minn.

130. Knuder, H. M. WIND EROSION GROWING MENACE TO ILLINOIS FARMS AND ROADS. State Off., SCS, USDA, Champaign, Ill.

131. Bierwagen, G. G. CONSERVATION SHOWPLACE FARM NOT BOthered BY DROUGHT NOW. SCS, USDA, Spearfish, S. Dak.

132. Duncan, M. R. COLORADO FARMERS-RANCHERS TAKE WIND OUT OF DROUGHT. SCS, USDA, Springfield, Colo.

133. Staff Writer. NEW EROSION/WATER CONTROL STRUCTURE: A STORY IN WORDS AND PICTURES.
Land & Water Contract. 6(5): 6-8. 1964.

A revolutionary new structure from a materials and installation point of view, one that land contractors have hailed for its ease and quickness of installation, was described and illustrated. In most cases, a three-man crew can install it completely, which includes, assembly, excavation, placement, and backfilling, in a single day.

A basic set of standard component parts for the Soil Saver is the "heart" of the design. These component parts can be simply arranged and used to make over 500 different sizes and models of water and erosion control structures. All the components — panels, connectors, and braces — are factory pre-fabricated of glass-fused-to-steel. Installation techniques and details of construction were simplified by the manufacturer.

The panels are bolted together at the construction site, or small structures can be pre-assembled. Joints are sealed with a high-quality mastic to make them water tight.

The glass-fused-to-steel panels combine these features: (1) The strength of steel; (2) protective glass-coating on all sides of panels and angles; (3) the glass coating is up to three times thicker than most other protective coatings; (4) the panels will take rough handing since the glass is tough and will flex with the steel; and (5) panels are unaffected by temperatures, or acids or alkaline soil conditions. Glass coated panel life was estimated at 40 to 50 years.

Headwalls of overfalls start at 2 feet and increase in 6-inch increments. The depth of the weir notch is in proper proportion to the headwall. Notch widths increase in 1 foot increments. These Soil Saver designs match Soil Conservation Service specifications.

Land Publications Inc., Barrington, Ill.

134. Hickey, W. C., Jr., and Dortignac, E. J. AN EVALUATION OF SOIL RIPPING AND SOIL PITTING ON RUNOFF AND EROSION IN THE SEMIARID SOUTHWEST. Internat'l. Assoc. Sci. Hydrol. 65: 22-23. 1963.

A cooperative study was started in 1958 to evaluate the relative effectiveness and duration of mechanical treatments produced by a soil "ripper" and soil "pitter."

Subsoil ripping was more effective in reducing runoff and erosion from test plots than were artificially built surface depressions or pits. Precipitation, surface runoff, and eroded material were measured for 3 years. A total of 82 runoff plots, each 310 square feet in area, were used. The study area was on the easily eroded shale-derived soils near Cuba, N. Mex.

For untreated soils, surface runoff was as high as 89 percent of storm rainfall, and erosion as high as 4,000 lb./A. Ripping reduced surface runoff 96 percent and erosion 85 percent in the first year after treatment. Three years after treatment, the reductions amounted to 85 percent for runoff and 31 percent for erosion.

Depressions or surface pits caused reductions of only 12 to 24 percent of surface runoff and 16 percent in erosion the first year after treatment. At the end of 3 years, surface runoff was reduced only 10 percent and erosion was about the same from treated and check plots.

It was observed early in the first year of study that some of the untreated (check) plots on the ripped site were failing to yield runoff, and some of the treated plots on the pitted site were improving in their ability to reduce surface runoff. A careful survey showed that subterranean channels were being formed and runoff was occurring below the surface of the ground. It is possible that the mechanical treatments initiated or speeded up this soil piping.

Rocky Mountain Forest and Range Expt. Sta., FS, USDA, Fort Collins, Colo.

135. Wooldridge, D. D. EFFECTS OF PARENT MATERIAL AND VEGETATION ON PROPERTIES RELATED TO SOIL EROSION IN CENTRAL WASHINGTON. *Soil Sci. Soc. Amer. Proc.* 28(3): 430-432. 1964.

In a preliminary study of physical properties of wild land soils, three soil parent materials were sampled by horizons under forest and adjacent grass cover. Soil properties analyzed were mean water-stable aggregate, bulk density, organic matter, pH, total porosity, and percent clay, silt, and sand. Several of the measured soil properties were related significantly to parent material and horizon depth. Effects of vegetative cover were not reflected in overall averages of soil property values. However, these values, broken down by parent materials and horizons, indicated that forest and grass covers were associated with soil property differences, although the relation of these differences to changes in parent materials and horizons was not consistent. Over 40 percent of the variation in soil erosion hazard (as measured by mean size of water-stable aggregates) was accounted for by multiple variation in soil organic matter content, pH, total porosity, and bulk density.

Pacific Northwest Forest and Range Expt. Sta., FS, USDA, Portland, Oreg.

Terracing

136. Staff Writer. TERRACING GROWS UP: THE EVOLUTION OF A BASIC LAND PRACTICE. *Land & Water Contract.* 6(6): 6-9. 1964.

New technological developments are launching a revolution in terracing to the gratification of farmers and land and water improvement contractors.

More than a quarter-century of widespread farmer experience and diverse research have been devoted to the many facets of terrace design, construction, and use.

A review of the evolution of terracing was given for the contractor.

The following types of terraces were discussed: (1) "Push-up" terraces; (2) parallel terraces; (3) bench terraces; (4) level terraces with tile outlets; and (5) Zingg terraces.

Land Publications Inc., Barrington, Ill.

137. Newman, J. C. WATERSPREADING ON MARGINAL ARABLE AREAS. *J. Soil Conserv. Serv. of N.S.W.* 19(2): 49-58. 1963.

A practical approach to the control of erosion on marginal cereal areas was described. The approach was based on fully utilizing the runoff water since water is a major limiting factor in production and stability in the area.

The technique of adapting waterspreading as a tool in the conservation of soil and water in these areas has proved to be of considerable value. In addition to the control of erosion, it allows a fuller utilization of annual precipitation. Run-off water, which is normally concentrated in gullies or in flow lines which would scour out when cultivated, can be spread over a large area reducing its erosive power and making more water available for crop and pasture growth.

Apart from the absorption and diversion structures normally used in conservation schemes, the following additional structures have been successfully used in water-spreading schemes in marginal arable areas: (1) Diversion spreader bank; (2) gap spreader bank; (3) gap absorption spreader bank; and (4) contour ditch. Combinations of these structures can be used to handle most of the erosion problems on the area.

The techniques described were: Relatively cheap to install; allow wide spacing of structures; provide adequate erosion control; eliminate the necessity of providing waterways; and encourage the maximum use of rainfall by crop and pasture. Each of these features is necessary to any method of erosion control in a marginal area. The technique can also be applied to areas to prevent erosion and to allow and increase safe crop production.

Res. Off., Condobolin, New South Wales, Australia.

Critical Areas

SEE 243.

SOIL MANAGEMENT

Cropping Practices

SEE ALSO 117.

138. Mannering, J. V., Johnson, L. C., Meyer, L. D., and Jones, B. A. THE EROSION-CONTROL EFFECTIVENESS OF ROTATION MEADOWS. *J. Soil and Water Conserv.* 19(3): 91-95. 1964.

Meadow crops in rotations are not outdated in today's agriculture as an effective method for reducing soil loss on sloping soils. Returning the stover from high-yielding corn to the soil does not provide erosion-control benefits equal to those derived from sod crops in rotations. Soil is more erosive under second-year rowcrop after meadow than under first-year rowcrop. These conclusions were based upon data obtained in 3 different years under simulated rainfall on a Verna sil on a 4 percent slope in northeastern Illinois, where corn yields under a high fertility program averaged about 80 bushels per acre and exceeded 100 bushels per acre in the years when rainfall was adequate. All the rainulator tests were made within a few weeks after corn or soybeans were planted. Plots in first-year corn lost 57 percent less soil than plots in second-year corn.

One or two full years of grass-and-legume meadow preceding corn was more effective than a red clover inter-crop carried over into the second corn year. The well maintained, 2-year meadow will exert a greater erosion reducing influence on second-year corn than the 1-year meadow.

Laboratory measurements of soil properties such as bulk density, organic matter content, aggregation index, and antecedent moisture helped to explain the variations in soil and water loss from the different crop rotation treatments. The soil property most closely related to soil loss by rainstorm erosion was aggregation.

Meadow crops reduce soil erosion primarily through their effects on soil physical properties such as porosity and aggregation that, in turn, influence infiltration, soil detachment, and transport. Land planted to the first-year rowcrop after meadow was more receptive to rainfall and the soil was more resistant to detachment and transport than rowcrop land 2 years or more from meadow.

SWCRD, ARS, USDA, Lafayette, Ind., 47907

139. Yegorov, V. Y., and Lykov, A. M. CHANGES IN ORGANIC MATTER IN SOD-PODZOLIC SOIL AFTER FIFTY YEARS OF CULTIVATION. *Soviet Soil Sci.* 10: 943-951. Oct. 1963.

The changes in organic matter in a sod podzolic soil after 50 years was determined in Russia. The author concluded that:

1. When field crops were grown without the use of organic fertilizers there was a loss of humus after 50 years, even under a crop rotation with clover. The presence of clover in crop rotation, a row crop, and pure fallow without the addition of fertilizer did not provide for a positive balance of organic matter in the soil.
2. The prolonged systematic use of fertilizers, primarily manure, reduced the losses of humus and nitrogen considerably in soil under crop rotation and provided for a continuous increase of their content in soil under continuous rye. The content of humic acids increased somewhat, the ratio of humic to fulvic acids widened, and the content of the most mobile fraction of organic matter decreased.
3. The liming of soil widened the ratio of the C of humic acids to the C of fulvic acids even more and increased the content of humins in the composition of soil humus. Consequently, in the cultivation of podzolic soils, lime actually achieved its natural function of "guardian" of fertility.
4. Prolonged soil cultivation with manure and mineral fertilizers changed the state of the nitrogen resources of the soil. The content of mineral and readily hydrolyzable nitrogen increased, but the accumulation of the major amounts of nitrogen in the soil took place as a result of the increased content of not readily hydrolyzable and non-hydrolyzable nitrogen-containing organic compounds.

Scripta Technica Inc., 1000 Vermont Ave., N.W., Washington, D.C., 20005

140. Triplett, G. B., Jr., Van Doren, D. M., Jr., and Johnson, W. H. NON-PLOWED, STRIP-TILLED CORN CULTURE. Trans. ASAE. 7(2): 105-107. 1964.

Corn has been successfully grown 3 years in Ohio without plowing or the use of secondary tillage implements. The key to success was satisfactory control of non-crop vegetation with herbicides without injuring the corn. On the average of 23 replicated experiments, there was no difference in corn yield between the no-tillage and conventional corn culture systems on soils ranging in surface textures from silt loam to clay.

Recognizable problems with no-tillage crop culture included: (1) Description of the optimum seed environment; (2) development of equipment to produce these conditions; (3) development of herbicide systems for economical production of corn and other crops in monoculture or rotation; and (4) description of the most desirable surface conditions for optimum crop growth and soil and water conservations. Other considerations included fertilizer-use efficiency and disease and insect control associated with no-tillage crop culture.

Ohio Agr. Expt. Sta., Wooster, Ohio.

141. Phillips, W. M., Anderson, L. E., and Campbell, R. W. CHEMICAL WEED CONTROL IN CROPS, 1964. Kans. Agr. Expt. Sta. B. 467, 16 pp. 1964.

Recommended chemical control methods for Kansas for 1964 were given for: Grain crops; legume crops; pasture weed control; turf and lawn; fruit crops; and vegetable crops.

A glossary of chemical names was included.

Agr. Expt. Sta., Kans. State U., Manhattan, Kans.

Crop Residue Management

SEE 81, 138, 143.

Tillage

SEE ALSO 134, 229.

142. Ford, Z. T., Chaplin, J. F., and Graham, T. W. EFFECTS OF SUBSOILING AND SOIL FUMIGATION ON FLUE-CURED TOBACCO. S.C. Agr. Expt. Sta. B. 514, 10 pp. 1964.

An experiment was conducted at the Pee Dee Experiment Station, Florence, S.C., from 1956-60 to gain information on the possible interacting effects of subsoil plowing and soil fumigation on flue-cured tobacco. Superimposed on the subsoil treatments were spring and fall fumigation with D-D soil fumigant.

Subsoiling offered no advantage in increased yields, value per cwt, acre value, or root-knot control except during 1959. During June in 1959, low rainfall and deficient soil moisture were associated with an increase of 62 pounds of cotton valued at \$47 per acre due to subsoiling. Subsoiling showed no effect on value per cwt. The increase of 135 lb./A. for the combined data (average 4 years) showed the effect of subsoiling on yield in the absence of soil fumigation. Root-knot control from fumigations was equally effective in spring and fall applications. Effectiveness of fumigation in root-knot control was not influenced by subsoil plowing.

Tables.

S.C. Agr. Expt. Sta., Clemson Col., Clemson, S.C.

143. Hauser, V. L., and Taylor, H. M. EVALUATION OF DEEP-TILLAGE TREATMENTS ON A SLOWLY PERMEABLE SOIL. Trans. ASAE. 7(2): 134-136, 141. 1964.

A study of the effect of three deep-tillage treatments on water-intake rate, water movement in the soil, crop yield, and duration of deep-tillage effects on Pullman silt loam was conducted at the Southwestern Great Plains Field Station in Texas during 1958-61. The tillage treatments studied were: Disk plowing 24 in. deep; vertical mulching 24 in. deep on 80-in. centers; chiseling 24 in. deep on 80 in. centers; and a check treatment that was not tilled below 4 in.

Disk plowing and vertical mulching increased the water intake rate about 1.9 and 1.5 times, respectively, the water intake rate for the check. Chiseling was relatively ineffective after one irrigation.

Free water accumulated in the vertical mulch slots during irrigation, and water moved from the slot into the adjacent soil. Sorghum residue placed in the vertical mulch slots was still intact after 3 years in the soil.

Deep disk plowing increased the rate of soil wetting. In 20 minutes, water penetrated to a depth of 6 ft. on plowed plots, but penetrated only the first foot on the check plots.

Grain sorghum yields were increased by deep disk plowing in only one of the 3 years. However, under conditions where the total amount of water available for plant growth depends upon the water intake rate, deep plowing probably would increase crop yields a greater proportion of the time.

SWCRD, ARS, USDA, Bushland, Tex., 79012

144. Pande, H. K., and Bhan, V. M. EFFECT OF VARYING DEGREE OF SOIL MANIPULATION ON YIELD OF UPLAND PADDY (ORYZA SATIVA) AND ON ASSOCIATED WEEDS. Canad. J. Plant Sci. 44(4): 376-380. 1964.

Eight levels of soil manipulations (broadly classified in the following three groups: (1) Dibbling; (2) plow-planting; and (3) plowing, harrowing, and planting) were tried on lateritic sandy clay loam soil of West Bengal (India) over a 2-year period, 1961-62, to ascertain the minimum level of tillage required for upland paddy, without sacrificing the yield.

Plowing, harrowing, and planting of the soil (group 3) significantly increased the grain yield and number of fertile tillers per meter row over the treatments of dibbling (group 1) and plow-planting (group 2). The latter treatments did not effectively reduce weed infestation, while the former brought about somewhat better control and the crop attained better growth, comparatively weed-free. The growth factors, height, leaf area, and dry matter, were directly related to grain yield with high correlation coefficients. Among the three treatments of group 3, the treatment of one plowing with moldboard plow, one harrowing with disk harrow, and planting, gave yields very close to the conventional tillage, i.e. plowing four times with country plow, harrowing, and planting.

Indian Inst. Tech., Kharagpur, India.

Fertility Requirements for Conservation Farming

SEE ALSO 28, 64, 69, 71, 73, 76, 79, 81, 83, 84, 88, 89, 92, 94, 95, 96, 97, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 117, 139, 175, 180, 186, 217, 219, 223, 236, 238, 295.

145. Bonnet, J. A. RESPONSE OF EIGHTEEN CONSECUTIVE SUGARCANE CROPS TO N-P-K IN PUERTO RICO. Puerto Rico Agr. Expt. Sta. Tech. B. 38, 63 pp. 1963.

The effect of N-P-K annual applications in 24 different treatments, on 18 consecutive crops of sugarcane, planted in acid Vega Alta c at Río Piedras, P.R., were studied. The fertilizer treatments consisted of a 4 X 2 X 3 N-P-K factorial replicated eight times. The increments were 103, 165, 227, and 289 pounds for N; 20 and 80 pounds for P_2O_5 ; and 90, 180, and 270 pounds for K_2O per acre, respectively.

The data per crop were collected as tons of cane or of sugar per acre, and as sucrose-percent-cane. The data were corrected for the effects of climate, soil fertility, and plot-block variations. Twenty-seven quadratic equations were developed for more reliable interpretation. The calculated data from the quadratic equations were expressed graphically together with the data obtained. A regression equation was derived from an economic statistical analysis of the data based on cost of fertilizer and its application, the cost of harvesting and hauling the cane, and the price of sugar. The results obtained were as follows:

1. In relative yields, expressed as tons of cane per acre; (1) A significant reduction at the lowest nitrogen level, 103 pounds of N per acre; (2) a highly significant rise at the highest nitrogen level, 289 pounds of N per acre; (3) no significant effect attributable to phosphorus; and (4) a highly significant rise at the highest potassium level, 270 pounds of K_2O per acre.
2. In relative values expressed as sucrose-percent-cane: (1) A significant rise at the second nitrogen level, 165 pounds of N per acre; (2) a highly significant reduction at the highest nitrogen level, 289 pounds of N per acre; and (3) no significant effect attributable to phosphorus or to potassium.

3. In relative yields expressed as tons of sugar per acre: (1) A significant rise at the highest nitrogen level, 289 pounds of N per acre; (2) no significant effect attributable to phosphorus; and (3) a highly significant rise at the highest potassium level, 270 pounds of K_2O per acre.
4. In profits as dollars per acre per year: (1) No significant effect due to nitrogen and to phosphorus; and (2) a highly significant effect attributable to the highest potassium level, 270 pounds of K_2O per acre.

The fertilizer treatment that sustained optimum yields in tons of sugar and economic profits, per acre per year, for the series of 18 consecutive sugarcane (POJ 2878 and PR 980) crops harvested in acid Vega Alta c at Río Piedras was 103-20-270 pounds of N - P_2O_5 - K_2O per acre per year.

Tables and graphs.

U. Puerto Rico, Agr. Expt. Sta., Río Piedras, Puerto Rico.

146. Ogle, W. L., Mack, K. B., and Cook, W. P. TOMATO FERTILIZATION IN COASTAL SOUTH CAROLINA. S.C. Agr. Expt. Sta. B. 512, 22 pp. 1964.

Nitrogen, potassium, and magnesium are usually the most important fertilizer elements limiting the production of tomatoes in coastal South Carolina.

The soil test was remarkably precise and accurate in predicting the crop needs for potassium when calibrated according to crop response. Soils testing medium and low should be fertilized with 200 and 300 pounds K_2O per acre respectively. For soils testing high or very high, 100 pounds is adequate. Indications are that the fertilizer should be applied as a split application.

The nitrogen needs of the tomato crop cannot be predicted in advance with the same accuracy and precision as potash needs, due to the many factors influencing the availability of nitrogen in the soil. Nitrogen fertilization becomes an individual field problem that must be adjusted as the season progresses to fit the situation. For coastal South Carolina, the amount used, when regulated correctly varied from 100 to 150 lb./A.

Soil tests indicate that phosphorus has accumulated in the soils used for truck crop production in the Beaufort-Charleston area. The soils tested ranged from high to very high in residual phosphorous. Yield response was not obtained from amounts of P_2O_5 that exceed 100 lb./A. on soils testing high or very high in residual phosphorus.

Magnesium deficiency symptoms expressed as yellow, chlorotic areas, between leaf veins and dark green veins were corrected by use of magnesium sulfate applied as a sidedressing 3 weeks after planting at the rate of 150 lb./A. With soils testing low or medium for available magnesium, the tomatoes should be sidedressed with 150 pounds of magnesium sulfate or at least 2 percent MgO from a quickly available source should be added to the fertilizer to attain best yield and quality.

Tables.

S.C. Agr. Expt. Sta., Clemson Col., Clemson, S.C.

147. Heiberg, S. O., Madgwick, H. A. I., and Leaf, A. L. SOME LONG-TIME EFFECTS OF FERTILIZATION ON RED PINE PLANTATIONS. Forest Sci. 10(1): 17-23. 1964.

Recent mensurational data obtained from fertilized and unfertilized plots of 30- to 35-year-old red pine plantations grown on coarse outwash sand demonstrated that very highly significant responses in increased total height and internodal growth, increased basal area, and decreased number of live whorls on dominant trees were due to potassium fertilization. Maximum height growth response was attained in the fifth

or sixth year followed by a slight decrease in response. Growth response was still 45 percent above unfertilized trees 20 years after fertilization. It was postulated that the longevity of response to potassium was due to the combination of a site inherently low in productivity plus a history of severe degradation by exploitive agriculture.

State U., Col. Forestry, Syracuse 10, N.Y.

148. Waddington, D. V., Troll, J., and Hawes, D. EFFECT OF VARIOUS FERTILIZERS ON TURFGRASS YIELD, COLOR, AND COMPOSITION. Agron. J. 56(2): 221-223. 1964.

Three fish by-product fertilizers and six commercially available turfgrass fertilizers were used to fertilize a lawn consisting of Marion bluegrass, common Kentucky bluegrass, and creeping red fescue. The fertilizers were applied to supply nitrogen at the rate of 5 pounds per 1,000 square feet per season. Yield, visual color, and chlorophyll content were useful criteria for evaluating the performance of turfgrasses under different fertilizer treatments, but, except for percent N, clipping analyses were less useful. Results obtained from some fertilizers which varied considerably in N, P, and K ratio and in source of nitrogen were similar. The fish by-product fertilizers, fishmeal, fish solubles, and a 10-6-4, compared favorably to fertilizers containing various sources of natural and synthetic organic nitrogen, but the fish solubles had an objectionable odor in spite of a masking additive.

Mass. Agr. Expt. Sta., Amherst, Mass.

149. Augustine, M. T., Thornton, R. B., Sanborn, J. M., and Leiser, A. T. RESPONSE OF AMERICAN BEACHGRASS TO FERTILIZER. J. Soil and Water Conserv. 19(3): 112-115. 1964.

The response of American beachgrass (*Ammophila breviligulata* Fern) to fertilization with various formulations of fertilizer was determined. Also tested were planting stock characteristics: (1) Number of culms per plant per planting hole; and (2) nursery-grown versus native planting materials.

Fertilizers included were: Nitrogen carriers only; complete conventional fertilizers; and controlled release fertilizers. Application methods for the fertilizers were modified to fit the type of fertilizer used and included banding and placement at the bottom of the planting furrow. Fertilizer practices were further modified by application at the time of planting and by side dressing the following spring.

There were no significant variance between the nursery and native stock with respect to response to fertilizer or survival. The total number of culms produced varied only slightly when one, two, or three culms were planted per planting hole.

Plant response to all fertilizer treatments significantly exceeded the level of plant growth on the unfertilized control. Single applications of soluble nitrogen or urea-formaldehyde (UF) resulted in relatively small increases in culm production. UF fortified with P and K produced small responses by plants. Responses to two applications of mixed conventional fertilizers resulted in a culm increase superior to that secured with straight nitrogen sources or the UF formulation. A single application of magnesium ammonium phosphate (MgAP) plus K produced plant responses superior to those secured with any other treatment.

American beachgrass was highly responsive to fertilizers and an effective cover for sand stilling was established much more rapidly with an adequate fertilization program than without one.

SCS, USDA, Beltsville, Md.

150. Alben, A. O., and Hammar, H. E. SOIL PENETRATION AND UPTAKE OF P AND K IN A 10-YEAR NPK FERTILIZER EXPERIMENT WITH SCHLEY PECAN TREES. *Soil Sci.* 97(3): 179-182. Mar. 1964.

A 10-year 2 X 2 X 2 NPK factorial fertilizer experiment on Yahola 1 with ammonium nitrate, triple superphosphate and muriate of potash, was reported.

Leaf sample analyses were made over a period of 10 years and soil samples were taken during the last 2 years.

Nearly all plots where triple superphosphate was added showed a higher available P content in the 0- to 6-inch, 6- to 12-inch, and 12- to 18-inch depths than the plots which received no triple superphosphate. The greatest differences were in the 0- to 6-inch depth.

Exchangeable K determinations were also averaged for the four blocks. The base exchange K was higher in the surface soil with and without addition of muriate of potash. A progressive decrease in the base exchange K occurred with depth. The muriate of potash treatments had more base exchange K at all depths than those not receiving potash.

The total base-exchange capacity was consistently higher in the surface 6 inches than in any other depth. In the remaining horizons, there was no consistent trend with depth except that the 24- to 30-inch depth was higher for most treatments than the 18- to 24-inch depth.

Results of statistical analyses of the data showed that the base exchange K was significantly increased when K was added at the 0.001 level for all depth increments sampled. Available P was significantly increased at the 0.001 level for the 0- to 6-inch and 6- to 12-inch depths and 0.05 for the 12- to 18-inch depths.

Leaf analyses data for phosphorus showed statistically significant annual increases over checks as follows: 1953, 1954, and 1956 at the 0.05 level; 1952, 1955, 1958, and 1959 at the 0.01 level; and 1960 at the 0.001 level. Increased K in the leaves was significant at the 0.001 level only in 1960.

CRD, ARS, USDA, Shreveport. La.

151. Boatwright, G. O., Ferguson, H., and Brown, P. L. AVAILABILITY OF P FROM SUPER-PHOSPHATE TO SPRING WHEAT AS Affected BY GROWTH STAGE AND SURFACE SOIL MOISTURE. *Soil Sci. Soc. Amer. Proc.* 28(3): 403-405. 1964.

The influence of periodic wetting of a dry surface soil on fertilizer P uptake at four growth stages was studied in the greenhouse using P-32.

Wheat plants did not absorb fertilizer P from a dry soil. At all stages of growth, there was a lag in fertilizer P uptake after watering and the length of lag increased with age of plant after the flag leaf stage. Only small amounts of fertilizer P were found in plants grown on soil that had been wet less than 80 hours. This suggests that showers and weather conditions which do not allow the fertilizer zone to remain wet for 3 to 4 days contribute little to fertilizer P uptake by wheat. Most rapid rate of fertilizer P uptake occurred when fertilizer and water were added at the flag leaf and 30 percent headed stages of plant growth, but when added at the completely head stage little fertilizer P was absorbed.

SWCRD, ARS, USDA, Bozeman, Mont., 59715

152. Sutton, C. D., and Larsen, S. PYROPHOSPHATE AS A SOURCE OF PHOSPHORUS FOR PLANTS. *Soil Sci.* 97(3): 196-201. Mar. 1964.

The value of pyrophosphate as a plant nutrient source was investigated by determining its rate of hydrolysis in soil, its adsorption characteristics, and its availability to plants, measured both in short-term water-culture experiments and in pot culture.

The hydrolysis of pyrophosphate in soil was found to be largely an enzymatic process, and the half-life in days (the time for 50 percent hydrolysis) could be predicted from the equation

$$t_{1/2} = \frac{1290}{c^{1.16}} \times 0.72^r$$

where $t_{1/2}$ = half-life in days; c = mg CO₂ evolved/day from 100 g. soil; and r = soil pH. Hence, in soils where the biological activity is not restricted, pyrophosphate will not persist long enough for differences between ortho- and pyro-phosphates to affect phosphorus uptake by plants and crop growth.

In a soil where pyrophosphate persisted, however, the P uptake recorded was lower than that from orthophosphate. Adsorption isotherm data showed that pyrophosphate was held less firmly than orthophosphate, and therefore the inferiority was likely to be due to a lower uptake by plants from solution.

Water-culture experiments at pH 6.5 showed P uptake from pyrophosphate to be less by a factor of 2.4 than from orthophosphate. From uptake data obtained at various pH levels, this difference was ascribed to the valencies of the predominant ions, H₂PO₄⁻ and H₂P₂O₇²⁻, which exist in solution at this pH.

Levington, Res. Sta., Ipswich, Suffolk, England.

153. Lehr, J. R., Engelstad, O. P., and Brown, E. H. EVALUATION OF CALCIUM AMMONIUM AND CALCIUM POTASSIUM PYROPHOSPHATES AS FERTILIZERS. Soil Sci. Soc. Amer. Proc. 28 (3): 396-400. 1964.

Six calcium ammonium and calcium potassium pyrophosphates were tested in the greenhouse as sources of P and N or K for two successive crops of corn forage on limed and unlimed Harsells fsl. The fertilizers were applied as powders and as pellet-granules; the residues of the granules were examined petrographically after harvest of the second crop.

The granules were much less effective than the powders as sources of P and N for the first crop, but only slightly less effective as sources of K. The powders were nearly as effective as superphosphate as sources of P and one of the ammonium compounds was nearly as effective as (NH₄)₂SO₄ as a source of N, but none of the K compounds was as effective as K₂SO₄ as a source of K.

The chemical alterations of the pyrophosphates in the soil were much like those of the same compounds in water, and all the observed alteration products were pyrophosphates. Some of the pyrophosphates show promise as long-term, slow-release sources of P and N or K.

Fundamental Res. and Soils Fert. Br., Off. Agr. and Chemical Develop., TVA, Wilson Dam, Ala.

154. Enyi, B. A. C. EFFECT OF VARYING PHOSPHORUS AND WATER SUPPLY ON GROWTH AND YIELD OF AN UPLAND RICE VARIETY (ORYZA SATIVA L.). Trop. Agr. 41(1): 47-53. 1964.

Waterlogging of an upland rice variety in pot experiments had no effect on tillering, but increasing the phosphorus supply to the plants increased tiller number. The percentage tiller mortality was lower under waterlogged conditions and at high phosphorus supply.

Waterlogged plants had a greater number of leaves during the early reproductive phase than dry soil plants, partly because of greater shoot number and partly because of the greater number of leaves per shoot in the former group of plants.

Increasing the phosphorus supply increased total leaf number at the tillering period and at the early reproductive phase. Waterlogged plants were taller at harvest than dry soil plants but during the vegetative period the reverse applied.

Waterlogged plants had greater grain weight and grain weight as percentage of straw weight than dry soil plants. Increasing the phosphorus supply increased the grain weight and the grain to straw weight ratio.

Waterlogging hastened the time of ear emergence, especially at the lower levels of phosphorus supply.

It was suggested that high phosphorus availability under waterlogged conditions only leads to adsorption in large quantity during the early reproductive stage rather than at the tillering phase.

Col. Agr., U. Nigeria, Nsukka, Nigeria.

Journal of Soil Science. STUDIES ON SOIL POTASSIUM. J. Soil Sci. 15(1): 1-41. 1964.

The March issue of the Journal of Soil Science contains the following four technical papers on Soil Potassium.

155. Beckett, P. H. T. CONFIRMATION OF THE RATIO LAW: MEASUREMENT OF POTASSIUM POTENTIAL. Oxford U., Oxford, England.
156. Beckett, P. H. T. THE 'IMMEDIATE' Q/I RELATIONS OF LABILE POTASSIUM IN THE SOIL. Oxford U., Oxford, England.
157. Tinker, P. B. CATION ACTIVITY RATIOS IN ACID NIGERIAN SOILS. Brown's Barn Expt. Sta., Highman, Bury St. Edmunds, Suffolk, England.
158. Tinker, P. B. EQUILIBRIUM CATION ACTIVITY RATIOS AND RESPONSES TO POTASSIUM FERTILIZER OF NIGERIAN OIL PALMS. Brown's Barn Expt. Sta., Highman, Bury St. Edmunds, Suffolk, England.
159. Mees, G. C., and Tomlinson, T. E. UREA AS A FERTILIZER: AMMONIA EVOLUTION AND BRAIRDING OF WHEAT. J. Agr. Sci. 62(2): 199-205. 1964.

The toxicity of urea drilled with cereal crops was studied as it affected ammonia evolution and brairding (germination). The author concluded that:

1. Moderate percentages of urea were widely and successfully used in compound fertilizers but the use of large proportions could be accompanied by two disadvantages: (1) The loss of nitrogen as ammonia from surface applications; and (2) the occurrence of toxic effects when urea and seeds were drilled together in soil. Both of these effects were consequences of the rapid hydrolysis of urea to ammonia and carbon dioxide.
2. The effect of brairding of the presence of urea and ammonium sulphate drilled with wheat seeds, and the loss of ammonia from top-dressings of the compounds on bare soils have been studied on a range of soils. Phytotoxicity was most pronounced in those conditions in which ammonia evolution was greatest. Thus, in a sandy soil, from which about 75 percent of the nitrogen of a top-dressing of urea was evolved as ammonia, more than 15 lb. nitrogen as urea per acre reduced the braird of wheat seeds; while in a clay soil, from which only 10 percent of a top-dressing was lost as ammonia, up to 60 lb. nitrogen as urea per acre could be added before braird was reduced.

3. Ammonia may be evolved from top-dressings of ammonium sulphate on calcareous soils, but not on acid soils. Brairding of wheat seeds was reduced by drilling with ammonium sulphate in soils from which ammonia was evolved; but in soils from which ammonia was not evolved the effect was less pronounced, and could be attributed to osmotic pressure effects. In soils from which comparable proportions of ammonia were evolved from both urea and ammonium sulphate the two compounds had similar effects on brairding.
4. On acid soils, adding acid salts to urea reduced ammonia evolution for a few days and this reduced brairding damage. In a calcareous soil, ammonia evolution was not reduced by acid salts and was increased markedly by $\text{NH}_4\text{H}_2\text{PO}_4$. In this soil, the presence of $\text{NH}_4\text{H}_2\text{PO}_4$ increased brairding damage by urea.
5. Adding neutral salts tended to increase the concentration of calcium in solution in the soil and decreased ammonia evolution. Precipitation of calcium increased ammonia evolution. These effects were closely correlated with the effects of salt-urea mixtures on the brairding of wheat.
6. Urea and ammonia solutions were drilled in soil with wheat. The dependence of toxicity upon concentration was similar for both compounds and both were equally toxic at the same concentration of nitrogen.
7. It was concluded that the toxicity of urea drilled with cereal crops was due to its conversion in soil to ammonia.

Imperial Chem. Indus. Ltd., Billingham Div., Jeallots Hill Res. Sta., Bracknell, Berkshire, England.

160. Court, M. N., Stephen, R. C., and Waid, J. S. TOXICITY AS A CAUSE OF THE INEFFICIENCY OF UREA AS A FERTILIZER: I. REVIEW. *J. Soil Sci.* 15(1): 42-48. 1964.

The causes and mechanisms of phytotoxicity that can bring about poor or adverse crop responses to applications of solid urea to soil were reviewed. Compounds which may cause phytotoxicity are urea, transformation products of urea formed during manufacture (biuret), and transformation products produced in the soil or in plants (cyanate, carbamate, ammonia, and nitrite).

The authors concluded that biuret would not seem to be a cause of phytotoxicity provided that less than 1 percent is present in the urea. The available evidence suggests also that cyanate is not the cause of damage arising from the use of urea.

Although toxicity due to urea itself is possible, this would seem unlikely under practical conditions. High concentrations of urea in solution can occur immediately around urea "granules" but this effect is only temporary. There is more danger perhaps where large amounts of urea are localized near the seed under relatively dry conditions.

When urea is hydrolysed in the soil, $(\text{NH}_4)_2\text{CO}_3$ is produced and causes a marked increase in soil pH. Above pH 7.0, it is possible for free- NH_3 to be present in the soil environment and, where these levels are high, plant damage may result.

The formation of large amounts of free ammonia together with soil pH values higher than 7.7 inhibits nitrite oxidation and allows nitrite accumulation, possibly to toxic amounts. As a consequence of ammonium-oxidation to nitrite, the soil pH will fall, probably below the threshold pH of 7.7 for nitrite oxidation. Despite the more favorable conditions of lowered ammonium-concentration and pH, the conversion of nitrite to nitrate may still be retarded by the inhibitory effects of the accumulated nitrite on the activities of Nitrobacter. At the lower pH vales, the toxicity of the nitrite to plants is likely to be greater.

The main causes of phytotoxicity from the urea (of low biuret content), applied below the surface of the soil, would appear to be from free ammonia and nitrite accumulation. The extent to which these are accumulated will be influenced by soil factors, by the rate and method of placement of the urea, and also by the materials applied with the urea.

U. Aberdeen, Aberdeen, Scotland.

161. Court, M. N., Stephen, R. C., and Waid, J. S. TOXICITY AS A CAUSE OF THE IN-EFFICIENCY OF UREA AS A FERTILIZER: II. EXPERIMENTAL. *J. Soil Sci.* 15(1): 49-65. 1964.

Plant damage and reduced yields were associated with delayed ammonification or nitrification of added urea-nitrogen. In a neutral sandy loam, the adverse effects of urea application were associated with the accumulation of toxic levels of first ammonia and later nitrite. Addition of hydrogen-ion as phosphoric or sulphuric acid alleviated the damage thereby supporting the conclusion that ammonia and nitrite accumulation were the causes of phytotoxicity.

In an acid sand, toxicity was associated first with the presence of large quantities of urea remaining in the soil though the evidence was insufficient to show in what way the urea was toxic. There was a second phase of toxicity associated with the presence of considerable quantities of ammonium-nitrogen under conditions where toxic levels of ammonia were likely to have occurred. The third phase (nitrite toxicity) did not occur. Phytotoxicity arising from the urea addition to the soil could be due apparently to the persistence of urea as such in the soil and also to the accumulation of significant quantities of free ammonia and nitrite. The occurrence of one or more of these phases of urea toxicity depended on differences in soil conditions.

Aberdeen U., Aberdeen, Scotland.

162. Crowder, L. V., Michelin, A., and Bastidas, A. THE RESPONSE OF PANGOLA GRASS (DIGITARIA DECUMBENS STENT.) TO RATE AND TIME OF NITROGEN APPLICATION IN COLOMBIA. *Trop. Agr.* 41(1): 21-29. 1964.

The influence of rate and time of applying N as urea to an established sward of pangola grass (Digitaria decumbens Stent.) was studied for 3 years at the Palmira Experiment Station in Colombia.

Dry forage production increased in a linear fashion with each additional increment of N up to 200 lb./A. applied at any one time and in a curvilinear manner with greater quantities. The highest total yields (up to 26 tons of hay per acre per year) occurred with the maximum amount of N topdressed (1,200 lb. per year) and for the treatment of N after every cut. More forage was harvested during each year from the plots receiving a total of 150 and 300 lb./A. of N after every second and third cut, but growth was not consistent and forage yields were greater for the harvests following the topdressing. The use of N after every cut gave a more even distribution of forage throughout the year. It would appear that from 75 to 100 lb./A. should be applied at intervals of approximately 2 months. The effect of N was transitory and disappeared in 3 to 4 months, regardless of the amount used.

Although crude protein percentage of harvested forage varied from cut to cut, an increase did occur with the rates of applied N. Averages for the upper limits were as follows: no N — 7.2 percent; 50 lb./A. of N — 7.7; 100 lb./A. N — 10.0; 200 lb./A. N — 13.0. The protein content declined unless N was added after every cut. The recovery of N, obtained in leaves and stems, was higher for the second and third years. After the first six cuts, applications of 100 lb./A. of N, or more, gave recovery rates of 50 to 75 percent.

Colombian Agr. Prog., Rockefeller Found., Bogotá, Columbia.

163. Olson, R. A., Dreier, A. F., Thompson, C., Frank, K., and Grabouski, P. H.
USING FERTILIZER NITROGEN EFFECTIVELY ON GRAIN CROPS. Nebr. Agr. Expt. Sta. B.
479, 42 pp. 1964.

Fertilizer nitrogen has proven a necessity for the efficient production of grain crops throughout the midwest.

Fertilizer nitrogen, where needed for optimum yield, usually slightly increased the total water used by the crop. The water required in making this optimum yield, however, was used a good deal more efficiently than where nitrogen was omitted.

Nebraska studies on fertilizer economy have demonstrated nitrate leaching losses were especially serious on sandy soils of low water holding capacity and with irrigation. Strong circumstantial evidence suggests denitrification of nitrate leached into the subsoil of some fine-textured subsoil types and the resultant escape of elemental nitrogen gas.

Ammonia volatilization losses have proved serious, particularly with surface broadcasting of products containing or producing ammonium ions on neutral or alkaline soils. Magnitude of ammonia evolution was accentuated by drying conditions and by surface residue where nitrogen carriers were applied in solution form. Loss by volatilization was reduced greatly as the fertilizer was mixed immediately with the soil.

Summer sidedressing of fertilizer nitrogen for row crops, regardless of chemical form, has usually proved superior to fall or spring applications. This superiority has been especially apparent at the lower application rates. Not only has this been noticeable in the year of application, but the carryover nitrogen effect has been greater than with earlier application times.

Soil incorporation and delayed application time was recommended for nitrogen fertilizer for grain crops.

U. Nebr. Col. Agr., Agr. Expt. Sta., Lincoln, Nebr.

164. Herdt, R. W., and Mellor, J. W. THE CONTRASTING RESPONSE OF RICE TO NITROGEN:
INDIA AND THE UNITED STATES. J. Farm Econ. 46(1): 150-160. 1964.

The functional relationship between nitrogen application and rice yield is strikingly different in the United States when compared to India. The optimal level of fertilizer application and the financial returns to use of fertilizer are much lower under Indian conditions than American conditions. The natural biological and physical factors examined did not provide an adequate explanation of these differences. The differences in the production functions are due primarily to the large and continuous input of research and technical training which have characterized the development of American agricultural productivity. Presumably, the same processes could also extend and shift the rice production function under Indian conditions.

Despite the strikingly lower yield response, the use of nitrogen provides an attractive return for those Indian farmers who have conditions similar to those of the India experiment stations reported. In the United States, more additional nitrogen fertilizer may be profitable than in India because of: (1) Demand by farmers for high risk premiums in discounting either the input-output relationships or prices in the United States; (2) share tenancy systems of the United States; and (3) the functions depicted for India provide little leeway to compensate for below-average levels of management or less responsive than average physical conditions.

Future plans for increased agricultural production in India are based in part on an eventual several-fold expansion in use of inorganic fertilizers. Such widening of fertilizer use will require research which shifts and extends the response curve up and to the right.

Jr. Author, Cornell U., Ithaca, N.Y.

165. Fox, R. L., Atesalp, H. M., Campbell, D. H., and Rhoades, H. F. FACTORS INFLUENCING THE AVAILABILITY OF SULFUR FERTILIZERS TO ALFALFA AND CORN. Soil Sci. Soc. Amer. Proc. 28(3): 406-408. 1964.

Field and greenhouse experiments indicated that 8-mesh elemental S was frequently inferior to sulfate forms of S for alfalfa and corn production on S deficient, acid, sandy soils in Nebraska. There was a marked increase in utilization of S from the elemental form during the second year compared with the first year after application.

Sulfur flour mixed with the soil was as effective as gypsum either mixed with the soil or side-banded at planting time for supplying S to young corn plants in the greenhouse. A sidebanded application of the S at planting time was much less effective than the same material mixed with the soil unless a small amount of CaCO_3 was also applied in the band. Sulfur utilization by young corn plants was linearly related to approximate specific surface of S particles obtained from 8-mesh material. The smallest particles, < 0.05 mm. in diameter, were slightly less effective than either S flour or gypsum applied at the same rate. The largest particles, 2.0 to 1.0 mm. in diameter, were relatively ineffective even at high rates of application. Superiority of S flour over 8-mesh material, at least under some conditions, appears to be associated largely with relative sizes of particles in the two materials.

U. Hawaii, Honolulu, Hawaii.

166. Walker, M. E., and White, A. W., Jr. EFFECTS OF LIMING ON CROP YIELDS AND CHEMICAL PROPERTIES OF TIFTON AND GREENVILLE SOILS. Ga. Agr. Expt. Sta. B. N. S. 108, 22 pp. 1963.

Field experiments on liming were conducted over a 5-year period in Georgia. Cotton, corn, and peanuts were grown on a Tifton ls at Tifton. Cotton and peanuts were tested on a Greenville scl at Plains.

Lime applications of up to 4,500 lb./A. were applied on the Tifton soil. The highest rate used on the Greenville soil was 6,300 lb./A. Generally the highest soil pH's for all lime treatments were recorded 12 months after liming on the Tifton soil and 18 months after liming on the Greenville soil.

Maximum soil pH's, from applied lime rates, were lower than anticipated. A high pH of 6.4 from the 4,500-pound rate was recorded on the Tifton soil. On the Greenville soil, where 6,300 pounds of lime was applied, a maximum pH of 6.7 was measured. In no case, was any evidence of overliming injury encountered. Soil profile acidity measurements showed effects on soil pH to a depth of 12 inches on the Tifton soil and to 9 inches on the Greenville soil.

Slightly higher soil pH's were measured for calcitic limestone as compared to the same rate of dolomitic limestone, but these were not great enough to effect any differences in crop yield responses. Differences in soil fertility measurements were not significant and only slight trends in increased levels of soil P and K were noted on the Tifton soil.

There were no significant yield response differences between the lowest and highest rates used. However, rates of up to 2 tons on the Tifton soil and up to 3 tons on the Greenville soil would be more practical from the standpoint of frequency of reliming.

Lime increased cotton yields at Tifton approximately 300 lb./A. over the 5-year period. Runner peanut yields were increased around 200 pounds during the same period. Corn yields were not significantly affected by liming, but lime treatments of 3,000 to 9,000 lb./A. outyielded unlimed treatments by 4 to 10 bushels. At Plains, where soil pH was generally high throughout the soil profile, yield responses of cotton and peanuts were low and not significant. However, cotton yields over the 5-year period were 100 lb./A. more than the unlimed plots.

Ga. Agr. Expt. Sta., Athens, Ga.

167. Ross, G. J., Lawton, K., and Ellis, G. B. LIME REQUIREMENT RELATED TO PHYSICAL AND CHEMICAL PROPERTIES OF NINE MICHIGAN SOILS. *Soil Sci. Soc. Amer. Proc.* 28(2): 209-212. 1964.

Lime requirement of 9 Michigan soils was determined by incubating the soils for 13 weeks in the greenhouse after addition of varying rates of agricultural limestone. The initial pH of all soils was approximately 5.5. Lime requirement was correlated with cation-exchange capacity, organic matter content, exchangeable hydrogen per 100 g. soil, clay content, and lime requirement measured by the Shoemaker, McLean, and Pratt buffer method. Increase in soil pH after liming was significantly correlated with increase in percent base saturation within each soil type, but not between soil types. Liming did not appreciably affect the amount of exchangeable Mg and K or extractable P in the soils. At pH 5.5, liming increased yield of Alfalfa on six soils, but not on the remaining three soils. Low yields were correlated with low calcium content in the plants.

Soil reaction alone and percent base saturation alone were inadequate criterial for evaluating lime requirement of soils.

Yield response to alfalfa to liming varied on different soil types at the same pH and could not be predicted from soil pH only.

Soil factors, other than pH, which were important in indicating lime requirements were: (1) Cation-exchange capacity; (2) organic matter content; (3) exchangeable hydrogen; and (4) clay content, arranged in order of increasing importance. Soil reaction in conjunction with these soil factors should give an accurate indication of lime requirements.

Mich. Agr. Expt. Sta., East Lansing, Mich.

168. Akesson, N. B., and Yates, W. E. AIRPLANE APPLICATION OF BULK FERTILIZER. *Trans. ASAE* 7(2): 137-141. 1964.

A report on the use of airplanes to apply bulk fertilizers on rice fields in California was given. Costs per hour for operating different types of airplanes were included.

Farmers and aircraft operators are aware of the shortcomings of the present systems and are looking for equipment improvements in agricultural aircraft which will benefit both the industry and the farmers they serve.

U. Calif., Davis, Calif.

Salinity and Alkali Problems

SEE ALSO 56, 96.

169. Sandoval, F. M., Benz, L. C., George, E. J., and Mickelson, R. H. MICRORELIEF INFLUENCES IN A SALINE AREA OF GLACIAL LAKE AGASSIZ: I. ON SALINITY AND TREE GROWTH. *Soil Sci. Soc. Amer. Proc.* 28(2): 276-280. 1964.

Considerable acreage of saline, imperfectly drained land in the northern Red River Valley of N. Dak. has a gently undulating microrelief or nearly level topography. In slight to moderate saline lands, the ridges are saline and the depressions relatively nonsaline. Salinity was studied in its relationship to microrelief under both shelterbelt and cultivated land use. Salinity in the ridge was composed primarily of magnesium and sodium sulfates. Exchangeable sodium was low and not a problem. Chemical compositions of shallow ground waters and saturation extracts of ambient soils were similar.

Soil salinity of the first foot of soil was less in the shelterbelt than in the adjacent cultivated area. This reduction near the surface within the shelterbelt was accompanied by a salinity increase at the 42- to 60-inch depth. The reduction was attributed to greater moisture adsorptive qualities of the established grassed areas and increased water supply from snow accumulation in the belt. Russian olive shrubs did poorly and frequently failed to survive when planted in soil having more than 10 millimhos per cm. estimated electrical conductivity, but they experienced little detrimental effects with 3 millimhos per cm. or less. Salinity of shallow ground water was much higher under ridges than depressions which indicated very limited crossflow.

SWCRD, ARS, USDA, Mandan, N. Dak., 58554

170. Longenecker, D. E., and Lyerly, P. J. MAKING SOIL PASTES FOR SALINITY ANALYSIS: A REPRODUCIBLE CAPILLARY PROCEDURE. *Soil Sci.* 97(4): 268-275. 1964.

A new procedure for making soil pastes for salinity analysis by capillary absorption of moisture was proposed. The method promises several advantages over the current procedure of hand-mixing. These are: (1) Better reproducibility of moisture content of the pastes by elimination of the variability occasioned by hand-mixing; (2) possibly better correlation between saturation extract values and soil cation-exchange equilibria due to a standardized wetting technique; (3) elimination of some of the difficulties inherent in making pastes with fine-textured and/or high-sodium soils; (4) introduction of a wetting procedure based on the natural moisture-adsorptive forces of the soil; and (5) probability that the proposed method may be more adaptable to large-volume service laboratory procedures.

Tex. Agr. Expt. Sta., Substation 17, Route 1, Box 454, El Paso, Tex.

171. Doering, E. J., Reeve, R. C., and Stockinger, K. R. SALT ACCUMULATION AND SALT DISTRIBUTION AS AN INDICATOR OF EVAPORATION FROM FALLOW SOILS. *Soil Sci.* 97(5): 312-319. May 1964.

The loss of water from field soil profiles with a water table at an average depth of 152 cm. was calculated from measurements of salt accumulation in various layers, with suitable adjustments being made for the molecular diffusion of salts downward from the surface and changes in the water content of the soil. Measurements of both the total soluble salt content and the chloride ion content were made as a function of both depth and time (1029 days) in initially leached and initially unleached plots. The surface remained fallow during the entire period. The capacity of the soil to transmit water upward (not the evaporative potential at the surface) limited the flow rate at all times during the study.

Evaporation rates of 0.055 ± 0.011 cm./day, using chloride measurements, and 0.065 ± 0.022 cm./day, using total salt measurements, were calculated for the leached plot. Rates of 0.072 ± 0.015 cm./day for the chloride measurements, and 0.096 ± 0.029 cm./day for the total salt measurements, were calculated for the unleached plot. Each calculation was based upon the measured salt accumulation in the top 30 cm. of the profile, the calculated diffusion of salt downward at the 30-cm. depth, and the measured changes in the water content of the surface 30-cm. layer. All error estimates were made at the 5 percent confidence level. Chloride measurements resulted in more precise estimates of the evaporation rate than did the electrical conductivity measurements. The results for the unleached plot compared favorably with results independently obtained by an evaprometer method.

Salt accumulation measurements on the top 90-cm. layer also gave reasonable estimates of the evaporation rate for the initially leached plot but gave negative results for the initially unleached plot.

Measurements of chloride content were preferred over calculations of total salt content from electrical conductivity measurements for the determination of evaporation. However, reasonable total salt accumulation determinations can be obtained from electrical conductivity measurements, if those measurements are made on sufficiently dilute soil: water extracts, so that all the soluble salts (gypsum included) are brought into solution. When gypsum is present, separate determinations of the soluble salt content of the soil solution are needed in order that the estimate of molecular diffusion can be made. Since chloride compounds remain in solution at all concentrations usually encountered in agricultural soils, the molecular diffusion of chloride can be estimated from concentration gradients calculated from the measured field moisture content and the measured chloride content at various depths.

U.S. Salinity Lab., SWCRD, ARS, USDA, Riverside, Calif., 92502

172. Sandoval, F. M., Benz, L. C., and Mickelson, R. H. CHEMICAL AND PHYSICAL PROPERTIES OF SOILS IN A WET SALINE AREA IN EASTERN NORTH DAKOTA. *Soil Sci. Soc. Amer. Proc.* 28(2): 195-199. 1964.

A large imperfectly drained saline soil area in the Red River Valley of North Dakota (glacial Lake Agassiz) was characterized chemically and physically.

The area studied was divided into the following principal physiographic areas: (1) The larger area comprised of deep lacustrine soils of low bulk density, frequently high Mg content, and soluble Na usually less than 50 percent of total soluble cations; and (2) a smaller area where dense glacial till was close to the surface and the soils had higher Na and B percentages. Soil and waters found along shallow drainways and sloughs draining the saline till area were laden with Na salts and probably toxic concentrations of B. The principal problem was excessive concentration of neutral water-soluble salts.

In the lacustrine soil area, Glyndon soils were more permeable than Bearden, which were frequently very slowly permeable although not especially dense. Soils in which glacial till occurred in the lower portion of the profile were dense and very slowly permeable below 36 inches. A close relationship was found between the saturation percentage and percent moisture retained at 15 bars suction for all the soils studied.

Mineral analysis of the lacustrine soils showed more dolomite than calcite. This has resulted in considerable Mg in soluble and adsorbed status. The predominant clay mineral for all soils observed was montmorillonite, followed by illite and kaolinite in that order.

Saline glacial till soils were more closely related chemically to saline artesian waters from the underlying Dakota sandstone geologic formation than were the deep lacustrine soils.

Aquifers apparently exist in the underlying glacial drift between the Dakota sandstone and the ground surface. Where the fine-textured lacustrine sediments overlie the drift, conditions appear impervious enough to reduce much of the potential leakage. Because the till soil area lies at higher elevation, slopes gently, and drains toward the lacustrine area, salts are continually being seeped toward the latter. Salinity reductions would be accelerated under a drainage program that would lower existing water tables.

SWCRD, ARS, USDA, Mandan, N. Dak., 58554

173. Kaddah, M. T., and Ghowail, S. I. SALINITY EFFECTS ON THE GROWTH OF CORN AT DIFFERENT STAGES OF DEVELOPMENT. *Agron. J.* 56(2): 214-217. 1964.

Two experiments were conducted in field plots on hybrid corn G. H. 67 and the open-pollinated corn, American Early. The plots were irrigated with tap water that contained about 370 p.p.m. soluble salts, and with tap water that contained 1,500,

3,000, 6,000, and 9,000 p.p.m. added salts. The salinity treatments were applied at three stages of development.

A third experiment was conducted with hybrid corn G. H. 67 in a sand culture. To the basal nutrient solution were added Na and Mg chlorides and sulfates and CaCl_2 , singly and in combination at concentrations of 1-, 2-, and 3-atm. osmotic pressures. Effects of these salts on germination and seedling growth and composition were studied.

The authors concluded that:

1. Corn was quite tolerant of salt during germination. Increasing salinity delayed germination but had no detrimental effect on percentage emergence.
2. Hybrid corn G. H. 67 yielded more grain and exhibited somewhat more tolerance to salt than American Early. The tolerance of both corn types increased with the stage of development. Stover yields were much less affected by salinity than were grain yields.
3. Corn seedlings were more tolerant of chloride than sulfate at equal osmotic concentrations. Under 1-atm. osmotic pressure, Na_2SO_4 , resulted in seedling growth equal to MgSO_4 , whereas NaCl depressed growth more than either CaCl_2 or MgCl_2 . With increasing concentrations, the reduction of growth was greater under Ca and Mg salts than under Na salts. Mixtures of salts generally resulted in more seedling growth than single salts, especially under the high added concentrations of 2 and 3 atmospheres.
4. The sum of total cation contents of seedling tops was not greatly affected by increasing salinity in the substrate since any increase in one or more cations was compensated to some extent by decrease in one or more other cations.
5. The reciprocal relationships between Ca and Mg were quite pronounced. Sodium salts induced moderate lowering of both Ca and Mg in tops.
6. Potassium contents in tops depended on both kind and concentration of salt in the substrate. High salt concentrations generally decreased the K contents of the tops with the sulfates causing a greater reduction than the chlorides. Under low and sometimes moderate concentrations of Ca and Mg salts, K contents in tops were higher than in the control.
7. Sodium in tops was generally low and was little affected by the addition of other salts.
8. Chloride in tops was increased by increasing chloride salts in the substrate and was depressed by increasing sulfates, especially MgSO_4 . N and P contents were generally little affected by increasing concentrations of the added cations and anions.

Soil Salinity Lab., Bacos, Alexandria, Egypt.

174. Agarwala, S. C., Mehrotra, N. K., and Sinha, B. K. INFLUENCE OF EXCHANGEABLE SODIUM ON THE GROWTH AND MINERAL COMPOSITION OF PLANTS: I. PADDY AND BARLEY. J. Indian Soc. Soil Sci. 12(1): 7-24. 1964.

The effects of ESP on the growth and mineral composition of barley plants grown in soils of sodium carbonate and bicarbonate series, each at nine ESP and of rice plants grown in soils of sodium carbonate, bicarbonate, and sulphate series, each at thirteen ESP were studied. Growth of barley and rice plants was depressed at high ESP on soils of the sodium carbonate and bicarbonate series. In the sodium sulphate series, there was hardly any growth depression in rice.

The authors concluded that with an increase in the ESP of the soils; (1) There was a marked increase in the tissue concentration of sodium in both barley and rice plants in soils of the sodium carbonate and bicarbonate series; in the sodium sulphate series there was no appreciable effect of ESP on tissue sodium in rice; (2) tissue concentration of phosphorus and manganese increased, while that of calcium decreased in both barley and rice plants; (3) tissue concentration of iron increased in rice

grown in the carbonate and bicarbonate series but not in the sulphate series; on the other hand in barley, tissue concentration of iron decreased in the carbonate series and there was no clear trend in the case of bicarbonate series; (4) in the carbonate and bicarbonate series, tissue concentration of potassium decreased in both rice and barley; (5) tissue concentration of magnesium decreased in both rice and barley in the carbonate series but showed a slight increase in the bicarbonate series; (6) tissue concentration of sulphur increased in barley in the carbonate and bicarbonate series and in rice, in the bicarbonate and sulphate series; and (7) in barley plant tissues, zinc decreased in both carbonate and bicarbonate series, while copper showed a decrease in the bicarbonate series and molybdenum an increase in the carbonate series.

Lucknow U., Lucknow, United Provinces, India.

Cover Crops and Green Manure Crops

SEE ALSO 127.

175. Cook, E. D., and Rector, C. W. THE EFFECT OF FERTILIZER AND SWEETCLOVER ON OAT FORAGE AND GRAIN YIELDS, BLACKLAND EXPERIMENT STATION, 1958-62. Tex. Agr. Expt. Sta. PR-2303, 3 pp. 1964.

Two field tests were started in 1958 to determine the response of oats in grain and forage yields to nitrogen and phosphorus fertilization when grown alone and in association with sweetclovers. The tests were fall-planted following grain sorghum and cotton crops.

Forage yields were increased only slightly with phosphorus fertilization. Phosphorus plus nitrogen increased yields an average of 1,000 lb./A. over the check. The use of sweetclover in association with oats increased forage yields 500 to 900 lb./A. over oats alone. Maximum yields were with fertilization and Madrid sweetclover. Forage yields averaged 450 pounds more when the crop followed cotton than following grain sorghum.

Grain yields were increased 1 to 4 bushels per acre with phosphorus fertilization and 14 to 19 bushels with phosphorus plus nitrogen. Sweetclover growing in association with oats did not influence grain yields when oats followed grain sorghum. Grain yields were increased 6 bushels per acre with Madrid sweetclover where oats followed cotton. Oats following cotton averaged 7 bushels per acre more than oats following grain sorghum.

Tex. A&M U. Tex. Agr. Expt. Sta., College Station, Tex.

Climatic Influences

SEE ALSO 12, 15, 21, 28, 40, 41, 42, 52, 59, 78, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 145, 151, 261.

176. Neuberger, J. W., and Sharp, A. L. STORAGE RAIN GAGE MEASURES RAINFALL AT REMOTE LOCATIONS. Agr. Engin. 45(4): 208-209. 1964.

The 2.5-inch-diameter orifice rain gages were satisfactorily used in place of the 8-inch rain gage for measuring rainfall under many conditions. All tests of the small orifice storage rain gages described and illustrated indicated that loss of rainfall from the storage bottle through evaporation was negligible.

Field tests and observations of the rain gage indicated that, where gross rainfall measurements are needed at remote gaging locations, several of the described storage-type gages can be constructed, installed, and maintained at much lower cost than standard 8-inch rain gages, and without use of any of the recognized anti-evaporation agents required to suppress evaporation in the standard gages.

SWCRD, ARS, USDA, Newell, S. Dak., 57760

177. Wheaton, R. Z., Kidder, E. H., and Eichmeier, A. H. VARIATION IN SUMMERTIME RAINFALL. Trans. ASAE 7(2): 114-115. 1964.

The spacing of rain gages in the Lake States ranges from 15 to 20 miles. The spacing of recording gages is about twice this distance. The intense storm of small areal coverage may be missed or only partially recorded. It is this intense storm that often produces the highest runoff from small drainage areas. Intense rainfall data is needed for the design of drainage and erosion control facilities for agricultural municipalities and highways.

To determine the intensity and areal extent of these storms, a dense network of recording rain gages was installed on Sloan and Deer Creek watersheds.

Five storms were selected to show the wide variation of summer storms over this 26 square mile area. The August 9, 1956, storm had rainfall amounts varying from 2.27 to 0.04 in. The gages which recorded these values were 6 miles apart. Most of this rain occurred during a 2-hour period. On July 4, 1957, a thunderstorm produced rainfall amounts ranging from 2.75 to 0.92 in. The distance between these gages was 6.75 miles. Seven gages within a distance of 5 miles recorded over 2 inches. This rain fell within a 3-hour period.

On July 11, 1957, three precipitation periods were recorded. One from 2 to 4 a.m., the second from 6 to 8 a.m., and a third from 3 to 7 p.m. The afternoon rainfall was of the highest intensity with 2 to 3 in. falling in the Sloan Creek basin. The quantity decreased to about 1 inch in the southern part of Deer Creek basin. Total precipitation for the day ranged between 3.88 and 1.80 in. The distance between these extremes was 8 miles. The rainfall on this date produced a peak runoff at 9 p.m. of 73 c.f.s. per square mile on Sloan Creek. The soils of Sloan Creek Watershed are over 95 percent of the imperfectly drained loam to clay loam textures. The channel slope is about 10 ft. per mile with watershed elevations ranging from 840 to 940 ft. above sea level. The normal design for very good drainage of this area using Sutton's C curve is about 26 c.f.s. per square mile.

The author concluded that the storms which occurred on the five selected dates show the wide variation of summertime rainfall which often exists within a small area and emphasizes the need of a dense recording rain gage network to determine the intensity and areal extent of these storms. The runoff from the storm on July 11, 1957, verifies that intense summertime storms produce high flows from small areas.

Mich. State U., East Lansing, Mich.

178. James, J. W. THE EFFECT OF WIND ON PRECIPITATION CATCH OVER A SMALL HILL. J. Geophysical Res. 69(12): 2521-2524. 1964.

Studies of the effect of wind on precipitation distribution in areas of low hill relief in Europe stimulated a similar investigation in western Oregon. Precipitation gages located on the windward and leeward sides of a hill were checked weekly and compared with wind speed data from a nearby U.S. Weather Bureau station. During the 3-month study period, January through March 1962, the windward precipitation gage recorded only 92 percent of the total of the leeward gage. The leeward gage received more precipitation than the windward gage during 9 of the 11 weeks in which precipita-

tion occurred during the 13-week study period. It was noted that the higher the wind velocities during precipitation the greater the catch on the leeward side of the hill except during a period of snowfall with moderate winds, when this distribution was reversed.

U.S. Army Natick Lab., Natick, Mass.

179. Shaw, R. H., and Waite, P. J. THE CLIMATE OF IOWA: III. MONTHLY, CROP SEASON AND ANNUAL TEMPERATURE AND PRECIPITATION NORMALS FOR IOWA. Iowa Agr. Expt. Sta. Sp. Rpt. 38, 32 pp. 1964.

The U.S. Weather Bureau has recently revised the monthly temperature and precipitation normals to cover the 30-year period, 1931-60. These normals were summarized for Iowa, and maps were prepared showing the average temperature and total precipitation for monthly, crop season, and annual periods. In addition, information was presented from which the temperatures that have percentage probabilities (5, 10, 25, 75, 90, and 95 percent) of occurring can be computed. Precipitation data were presented from which the probability of the driest one-third or of the wettest one-third of the periods can be obtained.

Agr. and Home Econ. Expt. Sta., Iowa State U. Sci. and Tech., Ames, Iowa.

180. Knoll, H. A., Lathwell, D. J., and Brady, N. C. THE INFLUENCE OF ROOT ZONE TEMPERATURE ON THE GROWTH AND CONTENTS OF PHOSPHORUS AND ANTHOCYANIN OF CORN. Soil Sci. Soc. Amer. Proc. 28(3): 400-403. 1964.

Corn plants were grown in sand cultures using a complete nutrient solution in which only the P level varied. Root zone temperatures of 15°, 20°, and 25° C. were used.

Two weeks after emergence, a number of plants were subjected to a sudden change in root zone temperature. The dry weight yield and the P content of the tops and the roots and the anthocyanin content of the tops were determined at 2 and 3 weeks.

Low root zone temperature severely restricted the growth of young corn plants. High P levels never fully counteracted this harmful effect. It was likely that reduced P uptake at low root zone temperature was caused primarily by a depression in root growth, induced by the low root zone temperature. Anthocyanic synthesis was stimulated by both a low root zone temperature and a low P level in the nutrient solution indication that purpling of corn was not necessarily an indication of P deficiency.

FMC International, FMC Corp., 633 3rd Ave., New York, N.Y.

181. Berry, C. R., and Hepting, G. H. INJURY TO EASTERN WHITE PINE BY UNIDENTIFIED ATMOSPHERIC CONSTITUENTS. Forest Sci. 10(1): 2-13. 1964.

A general decline of Pinus strobus L. in the Cumberland Plateau of Tennessee was determined, by an aerial survey, to be in the Kingston-Oak Ridge-Rockwood-Harriman industrial area. This disease, called post-emergence chronic tipburn, was also found in other industrial areas, including some which contained coal-burning power plants. Root and stem isolations yielded no primary pathogens. Pruning and fertilizing sometimes brought about improved vigor, but did not affect occurrence of needle tipburn, a primary symptom. Diseased trees transplanted out of the affected area recovered, while trees transplanted within the affected area continued to decline. Trees differed greatly in their susceptibility to the disease. Scions from susceptible trees displayed symptoms year after year even when grafted to resistant trees in the affected

area. Scions from resistant trees continued to be disease-free year after year even when grafted to diseased trees. The grafting experiment furnished evidence that a virus was not involved and indicated that the cause of the trouble was an atmospheric agent.

Members of susceptible clonal lines potted with the same soil mixture were injured when placed in the affected area, while other remained disease-free outside. This use of susceptible clones as biological indicators gave further evidence that the disease causal agent was atmospheric and that the level of resistance was genetically controlled. Analyses of diseased foliage showed that injury could occur without causing a conspicuous elevation of either sulfur or fluorine in needle tissues. Sulfur dioxide and fluorine were still regarded as possibly involved.

Southeastern Forest Res. Sta., FS, USDA, Asheville, N.C.

182. Rosenberg, N. J. SOLAR ENERGY AND SUNSHINE IN NEBRASKA. Nebr. Agr. Expt. Sta. Res. B. 213, 31 pp. 1964.

Direct solar radiation to the earth's atmosphere is steady and dependable. Receipts at the surface of the earth, however, vary depending upon season, day length, latitude, and upon local conditions of cloudiness and atmospheric turbidity.

Weather Bureau records of measured solar radiation useful in interpreting the solar energy regime in Nebraska are available from: Lincoln-Omaha, Nebr.; Dodge City, Kans.; Laramie, Wyo.; and Rapid City, S. Dak. Pertinent records of sunshine duration (percent of possible sunshine) are available from: Lincoln, Omaha, North Platte, and Valentine, Nebr.; Concordia and Dodge City, Kans.; Cheyenne, Wyo.; Rapid City and Huron, S. Dak.; and Sioux City, Iowa.

These records were subjected to statistical summarization and analysis. The author concluded that:

1. A comparision of Lincoln-Omaha and Laramie records indicates an east to west increase in solar radiation due apparently to lower atmospheric turbidity at the higher elevation of Laramie.
2. A comparision of Dodge City, Kans., and Rapid City, S. Dak., records indicates greater solar radiation at the southerly location despite the longer days in summer in the north. This is due to the more direct incidence of the solar beam at the southerly location.
3. The Lincoln-Omaha Region receives less radiation than do any of the other three locations studied. The difference between Dodge City and Lincoln-Omaha is significant at the 5 percent level of probability throughout the year.
4. Sunshine duration (percent of possible sunshine) patterns across the State change greatly during the year in Nebraska. A region of low sunshine duration is centered over Omaha in the Missouri Valley and a region of high duration is centered over Valentine in the northern Sandhills.
5. The proportion of weeks with high sunshine duration increases from early spring to late summer, decreasing to a low during the winter months.
6. Regression equations relating solar radiation and percent possible sunshine were presented for the three stations at which both parameters have been measured: Lincoln-Omaha, Nebr.; Dodge City, Kans.; and Rapid City, S. Dak. These indicate the greater dependency of solar radiation on sunshine duration at the two more southerly locations. Estimates of future maximum and minimum solar energy receipts may be made on a weekly basis for the locations represented by these equations. Probability may be applied to predict future percentages of possible sunshine for a given week. The projected percentages of possible sunshine may then be used in the regression equations to predict future solar radiations on a weekly basis.

7. Information was given sufficient to roughly characterize the solar radiation regime in regions of Nebraska in which percent possible sunshine alone has been measured.

Tables, charts, and graphs.

U. Nebr. Col. Agr., Agr. Expt. Sta., Lincoln, Nebr.

183. Shaw, L. H. THE EFFECT OF WEATHER ON AGRICULTURAL OUTPUT: A LOOK AT METHODOLOGY. J. Farm Econ. 46(1): 218-230. 1964.

Methodological problems involved in attempting to measure the impact of weather on crop yields were discussed. The weather index approach was advanced as a more appropriate analytical technique than multiple regression analysis. Attempts to analyze the role of improvements in technology have been greatly hampered by the year-to-year fluctuations in yields due to weather.

Several techniques were used to assess the impact of weather on agricultural output. The multiple regression approach, most suited to studies at the micro-level of crop yield-weather relationships, was used on an aggregate level as well. The difficulties involved in specifying appropriate variables and functional relationships as well as problems of aggregation limited its usefulness at this level.

ERS. USDA, Washington, D.C., 20005

Mulching

184. Bartee, L. D. EVALUATION OF MULCH MATERIALS FOR ESTABLISHING VEGETATION ON SMALL DAMS. Soil and Water Conserv. 19(3): 117-118. 1964.

Three mulch materials were used in establishing vegetation on floodwater retarding structures in that part of the Upper Washita watershed that lies on the eastern side of the Texas Panhandle to compare their costs and evaluate their characteristics. Mulch materials tested were hay, wood pulp (wood cellulose fiber), and forage sorghum grown for dead litter. All mulch materials resulted in satisfactory stands of vegetation. Native grasses adapted to the soil on the sites were planted with the mulches.

SCS, USDA, Pampa, Tex.

PLANT MANAGEMENT

Pasture and Haylands

SEE ALSO 62, 69, 71, 91, 93, 101, 108, 109, 138, 141, 153, 162, 165, 167, 194, 265, 268, 291, 295.

185. Sprague, M. A., Cowett, E. R., and Adams, M. V. EARLY AND DEFERRED CUTTING MANAGEMENT OF ALFALFA, LADINO WHITE CLOVER, BROMEGRASS, AND ORCHARDGRASS. Crop Sci. 4(1): 35-38. 1964.

Twelve cutting systems were applied for 2 years to alfalfa and ladino clover, each grown in mixtures with bromegrass and orchardgrass. Stand and subsequent yields indicated performance and persistence of the components of each mixture.

Survival of alfalfa was influenced more by late summer cutting schedules than spring and mid-summer cuttings. Late summer cuttings at an immature stage of maturity were deleterious to both stand and yield. The grass partners with alfalfa persisted best when the majority of cuttings were at immature stages, and particularly when the last cut of the season was as pasture.

Ladino clover persisted best when harvests, early in the season, were at pasture stages. The grasses with ladino clover did not perform the same as when growth with alfalfa. Alfalfa was the more competitive legume and orchardgrass the more competitive grass.

Rutgers — The State U., New Brunswick, N.J.

186. Suman, R. F., Woods, S. G., Peele, T. C., and Godbey, E. G. BEEF PRODUCTION FROM SUMMER GRASSES IN THE COASTAL PLAIN. S.C. Agr. Expt. Sta. B. 509, 22 pp. 1964.

The summer grasses — Coastal bermuda, Pensacola bahia, and common bermuda — were fertilized with three rates of nitrogen, 100, 200, and 400 lb./A., and the forage grazed with yearling steers. Coastal bermudagrass was also rotation grazed. Management procedures were evaluated during the first year, and improvements made in succeeding years. The following conclusions were reached:

1. Coastal bermudagrass gave the highest beef gains per acre. Gains from common bermudagrass and Pensacola bahiagrass were similar and approximately three-fourths that of the Coastal bermudagrass. Gains with Coastal bermudagrass reached 1,000 lb./A. in 2 of the 4 years.
2. Approximately 200 pounds of nitrogen per acre was adequate for grazing. More forage was produced with 400 pounds of nitrogen per acre, but the additional animals required to keep it grazed wasted much of it. The nitrogen was applied in split applications — early spring and June.
3. Rotational grazing of Coastal bermudagrass increased beef gains very little. With high rates of fertilization, rotation of the steers facilitated the handling, so that pasture fertilization, top-dressing, etc., could more easily be accomplished.
4. When steer numbers per acre were increased too greatly, gains were less than 1 pound per day. When the steer number was reduced to not more than five head at any time, gains per head were 1.39, 1.36, and 1.19 for common bermudagrass, Coastal bermudagrass, and Pensacola bahiagrass, respectively.
5. The quality of the grasses was adequate for grazing under all conditions. The protein content of the grasses varied from 20 percent in the spring to less than 10 percent in the fall.
6. There was a small change in soil fertility during the test.

Tables, graphs, and photographs.

S.C. Agr. Expt. Sta., Clemson Col., Clemson, S.C.

187. McCaleb, J. E., Peacock, F. M., and Hodges, E. M. OATS AND RYE FOR GRAZING ON FLORIDA FLATLANDS. Fla. Agr. Expt. Sta. C. S-152, 15 pp. 1964.

Oats and rye were compared for their grazing value in a 4-year trial. Gator rye was not available commercially until 1958; therefore, the years 1958-59 yielded the most comparable data and were used in the summary.

The average number of grazing days per year was 114.5 for each variety. The number of acres per steer was 1.00 for Floriland oats and 1.29 for Gator rye. The average annual steer gains per acre were 270 pounds for oats and 165 for rye. Daily gains were 1.88 and 1.70 for oats and rye, respectively. The selling price per 100 pounds live weight was comparable, but gross returns per acre averaged \$60.00 for oats and \$36.99 for rye.

The analyses of air-dry oats and rye forages showed no appreciable difference. The high protein content of oats and rye was above the minimum requirements for fattening cattle, and these forages could be more efficiently utilized by cattle fed an energy feed supplement.

The average costs of \$52.49 per acre per year showed that on the basis of these trials, oats or rye cannot be recommended as an economical crop for grazing beef animals. Oats, however, can be used satisfactorily on the sandy soils of southcentral Florida when used in conjunction with other programs.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.

188. Spooner, A. E. LAMB GRAZING TRIALS ON WINTER SUPPLEMENTAL PASTURES. Ark. Agr. Expt. Sta. B. 689, 21 pp. 1964.

Lamb grazing trials were conducted during the fall and spring grazing seasons of 1957-62. Wheat, oats, barley, crimson clover, and vetch were used in the 1957-58 season. From 1958-62, wheat and oats were seeded alone at different rates, together, and in combination with crimson clover.

Pasture production was measured by grazing the forage with western lambs. The following data were recorded: Daily gains; lamb days per acre; lamb gains per acre; and lamb grades when placed on and taken off pasture.

The author concluded that: (1) Barley and vetch did not produce satisfactory gains on lambs. (2) Oats produced higher gains than wheat during the fall grazing period; however, the reverse was true for the spring period. (3) There was a tremendous amount of winter damage and kill on oat plants, with no apparent damage to wheat plants. (4) Oats, in general, produced higher daily gains than wheat, whereas wheat produced higher lamb gains and significantly more lamb days per acre. (5) Crimson clover seeded with wheat and oats produced higher lamb gains per acre than the wheat and oats seeded alone. Daily gains were increased when crimson clover was seeded with wheat, but not when it was seeded with oats. And (6) the grades of the lambs were increased during each grazing season but the finish was not satisfactory to meet the requirements for fat slaughter lambs. A short feeding period of grain should be considered for pasture grazed lambs.

Agr. Expt. Sta., Div. Agr., U. Ark., Fayetteville, Ark.

189. Marten, G. C., Jordan, R. M., and Wedin, W. F. EFFECTS OF OATS-RAPE INTERSEEDING AND LAMB-GRAZING ON CORN YIELD. Agron. J. 56(2): 205-208. 1964.

Lambs were permitted to graze in corn interseeded with an oats-rape mixture at the time of corn cultivation in three experiments at Rosemont, Minn., from 1960-62. Grazing commenced after that oats-rape was 6 to 8 inches high and when corn height ranged from 3 to 7 feet, and the lambs were removed from treatments during September. Major findings of the study were:

1. In 1960, the 84-day lamb grazing period (July 7-September 29) resulted in a 22 to 42 percent corn yield reduction, indicating that all treatments were detrimental to yield; treatments included interseeding or not interseeding corn with oats-rape and presence or absence of CDAA to provide within-row weed control.

2. With a 43-day grazing period (July 20-September 1) in 1961, no significant change in corn yield was detected; with a 62-day period (July 20-September 20), however, yields were reduced 15 to 20 percent. Interplanting with oats-rape did not affect corn yield.
3. In 1962, major corn yield losses occurred under all treatments, averaging 32 percent, 31 percent, and 35 percent, respectively, for grazing periods of 41 days (July 25-September 4), 55 days (July 11-September 4), and 56 days (July 25-September 19). Interseeding with oats-rape caused the majority of yield loss under the grazing treatments, and was responsible for an average yield reduction of 25 percent.
4. Losses in corn yields that could be directly attributed to damage by grazing lambs appeared to be due more to stalk breakage than leaf removal.
5. Pasturing lambs in corn after early September resulted in more severe damage to the grain yield than removal of lambs by that date in all 3 years. Delaying entrance of lambs into standing corn until the stalks reached 6 feet or higher showed no apparent advantage over (grazing) when corn was 3 to 4 feet high.
6. Lamb performance under the various 84-day grazing treatments in 1960 fluctuated from 72 to 117 lb./A. (with average daily gains (A.D.G.) of 0.19 and 0.31 pound) for non-interseeded and interseeded corn, respectively. Lamb per acre in 1961 ranged from 81 to 83 pounds (with A.D.G. of 0.43 and 0.30 pound) under the 43-day and 62-day grazing periods, respectively. Pounds of lamb produced per acre in 1962 were 31, 41, and 75 accompanied by 0.13, 0.14, and 0.22 A.D.G. for the respective 41-day, 55-day (early season), and 56-day (late season) treatments.
7. The low return of lamb per acre, along with uncertainties regarding corn yield, precluded the general recommendation of the practice of grazing lambs during the growing season in corn fields that had been planted with an inter-row crop of oats-rape. Under ideal conditions and with a short grazing period (43-days), the practice allowed a small economic profit; with less desirable conditions or long grazing periods an economic loss was incurred.

CRD, ARS, USDA, St. Paul, Minn.

190. Chapman, H. L., Jr., Peacock, F. M., Kirk, W. G., Shirley, R. L., and Cunha, T. J. SUPPLEMENTAL FEEDING OF BEEF CATTLE ON PASTURE IN SOUTH FLORIDA. Fla. Agr. Expt. Sta. B. 665, 28 pp. 1964.

Currently available information on feeding supplemental minerals and feeds to beef cattle in south Florida was summarized. Many factors affect the nutritional requirements of beef cattle. Information was presented to give the cattleman a basis to determine the advisability of providing cattle with supplemental feed and, if needed, the best kind of supplemental feed to use. Current, recommendations for minerals mixtures were presented. The major emphasis concerned cattle on the principal pasture forages of south Florida.

The nutritional requirements of beef cattle are affected by age, sex, breed, condition, stage of life cycle, and purpose for which the cattle are to be used. Factors affecting the extent to which a particular supplemental feeding program is used include kind of feed and pasture forage available, degree of specialization being followed, physical facilities available, and relative prices of cattle and feed. The responses of cattle to any feed at any given time are affected by factors such as the genetic potential of the cattle, degree of disease present, parasites, and environment.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.

191. Chapman, H. L., Jr., Green, V. E., Jr., Haines, C. E., and Kidder, R. W.
PRODUCTION AND UTILIZATION OF CORN SILAGE ON ORGANIC SOIL. Fla. Agr. Expt. Sta.
B. 679, 19 pp. 1964.

Thirty years of research have proved that with proper production practices, large tonnages of field corn can be produced annually. Field corn, when grown for silage on the organic soils, produced a higher yield of ensilage per acre than pearl millet, sorggrass, or sorghums. Highest yields in south Florida were obtained by plantings made by the end of February. Recommended varieties for corn silage production were presented.

Three experiments, involving 120 steers, were conducted to determine the value of bacitracin, zinc-bacitracin, or Zymo-Pabst as preservatives for corn silage produced on the organic soils of the Everglades. Bacitracin did not stimulate rate of gain. Zinc-bacitracin increased the rate of gain in one experiment and not in another. The enzyme preparation Zymo-Pabst increased gain 10 percent in one experiment and about 6 percent in another. The silage preservatives had no significant effect on carcass grades or dressing percent. Except for the zinc-bacitracin group during the second experiment, steers receiving the treated silages required less dry matter intake per pound of gain than those receiving the untreated silage.

U. Fla. Agr. Expt. Sta., Gainesville, Fla.

Rangelands

SEE ALSO 13, 111, 117, 141, 194, 256.

192. Schuster, J. L. ROOT DEVELOPMENT OF NATIVE PLANTS UNDER THREE GRAZING INTENSITIES. Ecology 45(1): 63-70. 1964.

The cumulative effects of two grazing intensities on the characteristics of individual plants and community root patterns on ponderosa pine-bunch grass ranges were studied. The species described were mountain muhly, Arizona fescue, blue grama, fringed sagebrush, and Rocky Mountain pussytoes.

Root samples excavated from ranges grazed moderately and heavily for 17 years were compared with samples taken from ungrazed exclosures. The number of roots extending below the 2-ft. soil depth level was similar in ungrazed exclosures. The number of roots extending below the 2-ft. soil depth level was similar in ungrazed and moderately grazed area, but significantly less in heavily grazed pastures. Maximum root penetration was as deep under moderate grazing as in the ungrazed exclosures, but with the exception of pussytoes, root extension was least under heavy grazing. Lateral root spread of the three grasses was proportionately less under moderate and heavy grazing, while lateral spread of fringed sagebrush and pussytoes was greatest under moderate grazing and approximately the same in ungrazed and heavily grazed areas.

Total root weight was reduced by moderate and heavy use. Grass root weight was significantly greater under no use than under moderate and heavy use, but nongrass root weight did not vary significantly. With the exception of nongrasses in ungrazed areas, 78 percent or more of the total root weight was found in the top 1-ft. depth section. The proportion of total root weight found in the top foot of soil was greater in heavily grazed than in moderately grazed and ungrazed areas. Grazing apparently caused a greater reduction in root weight in the top 1-ft. section than in other levels, but the decline in root weights with grazing was proportionately greater at deeper levels.

In general, the reductions in root systems were in proportion to the amount of use the individual species received under the given intensity of grazing. Root patterns under no grazing were dense, heavily branched, spreading, and deeply penetrating. Roots had progressively fewer branches and were sparser and shorter under moderate and heavy grazing.

Southern Forest Expt. Sta., FS, USDA, Nacogdoches, Tex.

193. Crockett, J. J. INFLUENCE OF SOILS AND PARENT MATERIALS ON GRASSLANDS OF THE WICHITA MOUNTAINS WILDLIFE REFUGE, OKLAHOMA. Ecology 45(2): 326-335. 1964.

The basal area and relative composition of the grassland communities of the Wichita Mountains Wildlife Refuge were determined by the point-contact method. Basal area varied from 13 to 16 percent in communities with a considerable amount of exposed rock, from 18 to 20 percent on tall grass sites, and to a maximum of 27 percent on the shallow-soil short-grass areas. Based on relative abundance of the most frequent species, there were nine distinct grassland faciations on six soil types and four geological formations. When topography was considered, further delineations raised the total to eleven.

Several of the areas supported the same major dominants but there were often significant differences in abundance. Andropogon scoparius made up 24 to 48 percent of the stand in eight of the eleven faciations, Andropogon gerardi provided 10 to 40 percent in ten types and Bouteloua hirsuta composed 11 to 35 percent in four types. These species were the major dominants from the 50 grass species, 4 genera of sedges, and 64 species of forbs in the samples. Forbs such as Coreopsis tinctoria, Vernonia baldwinii, Crysopsis villosa, Liatris punctata, and Gaillardia pulchella were valuable seasonal indicators of soil types although the most abundant forb, Ambrosia psilostachya was not. Definite correlations existed between soil types and vegetation and between geological formations and vegetation. The correlation of vegetation with a combination of soil type and geological formation was better than with soil type alone.

Oklahoma State U., Stillwater, Okla.

Plant Materials

SEE ALSO 210, 219, 260.

194. Rhoades, E. D. INUNDATION TOLERANCE OF GRASSES IN FLOODED AREA. Trans. ASAE 7(2): 164-166, 169. 1964.

The ability of grass to withstand given periods of submergence seemed to depend on plant physiology of the species. Some species were more tolerant to inundation than others; also, as the depth of flooding increased, the inundation tolerance decreased. Grasses were only slightly affected by submergence while semidormant. However, during the growing season they were injured in varying degrees by short periods of flooding. Variation in the flooding tolerance of grasses suggested the possibility of contour planting of selected species, based on the expected duration of inundation of a given level in the detention pool.

In areas where adapted, grass species such as Bermudagrass, buffalograss, vine-mesquite, prairie cordgrass, KSU lowland switchgrass, and common lowland switchgrass would be recommended for establishment in the detention pool area where the expected inundation duration ranged up to 20 days. Caddo switchgrass and upland common switchgrass would be recommended where the expected inundation ranged up to 15 days. Eastern gamagrass, alkali sacaton, El-Kan bluestem, KR bluestem, and weeping livegrass would be recommended where the expected inundation duration ranged up to 5 days.

SWCRD, ARS, USDA, Chickasha, Okla., 73018

195. McNeal, X., and York, J. O. CONDITIONING AND STORING GRAIN SORGHUM FOR SEED. Ark. Agr. Expt. Sta. B. 687, 15 pp. 1964.

The following series of studies were carried out on grain sorghum drying: (1) Small samples of grain were subjected to different drying temperatures; and (2) samples were dried in 16-bushel and 100-bushel bins using natural air and heated air. In each case, germination was used as the measure of the condition of the grain after storage.

Grain sorghum for seed should be harvested when the moisture content is near 20 percent or less, and dried promptly to below 11 percent before being stored. Temperatures of 130° F. or less should be used for grain sorghum dried in a commercial dryer. The highest over-all germination resulted when grain sorghum was dried at 110° F. However, when samples of grain sorghum relatively low in moisture content were combined and dried at 140° F., they produced higher average germination than samples that were harvested at high moisture content and dried at temperatures of 110° F.

Grain sorghum that was bin-dried with natural air or with supplemental heat produced higher germination when the moisture content at harvest time was below 20 percent. Grain sorghum was bin-dried satisfactorily with air that was as much at 20° F. above air temperature. More than a 20° temperature rise may result in overdrying of the grain where the air enters the bin. In the study air was supplied to the bottom of the bins at a rate of approximately 2 cu. ft./bu./min.

Agr. Expt. Sta., Div. Agr., U. Ark., Fayetteville, Ark.

Woodlands

SEE ALSO 8, 79, 104, 111, 118, 141, 169, 181, 260.

196. Wilde, S. A. RELATIONSHIP BETWEEN THE HEIGHT GROWTH, THE 5-YEAR INTERCEPT, AND SITE CONDITIONS OF RED PINE PLANTATIONS. J. Forestry 62(4): 245-248. 1964.

Analyses of soils and growing stock of Wisconsin red pine plantations disclosed that irregularities in the rate of height growth were caused by the following conditions: Deficiency of nutrients in the surface soil layers depleted by previous fires and farming; severe podzolization; variation in the nutrient supply of substrata; position of the ground water; and rank growth of weeds. The effect of these factors was reflected in the ratio of the average height increment (H) and the 5-year intercept (I), calculated in inches on a per annum basis.

Within the age range of 20 to 40 years, plantations established on soils underlain by infertile substrata or a shallow water table were characterized by low values of H/I quotient descending with age from 0.8 to 0.6. Plantations of the same age span established on the following type of soils exhibited high values of the quotient, ascending with age from 0.9 to 1.3: (1) On weed-invaded soils (especially those of fine texture); (2) soils with depleted surface layers that were underlain by substrata enriched in aluminum-silicate minerals; and (3) soils with ground water at depths from 4 to 10 feet.

The importance of the chronological pattern of growth and the polymorphism of natural growth curves, indicated by the H/I quotient was emphasized. Rigid ecological stratification of mensuration results was suggested as a means of reducing complications of statistical analyses by erratic data, and eliminating gross errors in appraisal of young plantations on the basis of their immediate site index.

U. Wis., Madison, Wis.

197. Buck, P. RELATIONSHIPS OF THE WOODY VEGETATION OF THE WICHITA MOUNTAINS WILDLIFE REFUGE TO GEOLOGICAL FORMATIONS AND SOIL TYPES. Ecology 45(2): 336-344. 1964.

Forest stands are found on four soil types and five geologic formations in the Wichita Mountains Wildlife Refuge in southwestern Oklahoma. Data on basal area, density, frequency, and reproduction were obtained from 52 relatively undisturbed stands. Post oak (Quercus stellata) was the most important tree species on all soil types and geologic formations; blackjack oak (Q. marilandica), the second most important species, had an importance value over 75 only on the Cobbley colluvial soil and the Post Oak Conglomerate, two very closely related categories. Little bluestem (Andropogon scoparius) was the most prominent herb on all categories except the Quanah formation where it was supplanted by big bluestem (A. gerardii). A decrease in herbaceous basal area with an increase in tree basal area was evident on all soil types, other than Rough stony soils.

Delineation of soil types and geologic formations by associations of woody plants was not possible within the refuge. Edaphic and topographic conditions frequently combine to produce microclimates which support small patches of vegetation dominated by species of minor importance overall. One example is the local dominance of sugar maple (Acer saccharum) on the north-facing slopes. The soil type appears more closely related to these microclimates than does the parent material.

U. Okla., Norman, Okla.

198. Wilde, S. A. CHANGES IN SOIL PRODUCTIVITY INDUCED BY PINE PLANTATIONS. Soil Sci. 97(4): 276-278. 1964.

Analyses of soils and timber of 156 Wisconsin plantations of Pinus banksiana, P. resinosa, and P. strobus disclosed the ability of forest stands to increase the soil content of organic matter. The relationship between the percentage of humus and the age of stands was expressed by a linear regression $Y = 0.07 + 0.11 x$, with $r = 0.732$ and $S.E. = \pm 0.58$. The soil-ameliorating effect has direct bearing upon the significance of contemporary soil surveys as regards silvicultural land utilization.

For purposes of reforestation, the value of a soil map prepared without benefit of soil organic matter determination was highly questionable. Depending on degree of soil depletion in humus, soils of the same surveyed type supported pine plantations whose yields at 35 years ranged from less than 10 to more than 25 cords per acre. After the age of 35 or 40 years, pine stands usually corrected temporary soil deficiencies caused by logging, fires, cultivation, or grazing. Subsequently, the contents of organic matter and nutrients ceased to be limiting factors, and the growth of forest stands, their stability, quality of timber, capacity for natural reproduction, and the reforestation potential of logged areas became closely correlated with less dynamic features of the site — its physiography and pedogenesis. In turn, soil survey units acquired far-reaching importance with respect to forest management.

U. Wis., Madison, Wis.

199. Hopkins, H. E. MANAGEMENT OF DOUGLAS-FIR IN NORTHWESTERN CALIFORNIA. J. Forestry 62(4): 233-237. 1964.

Management of the Douglas-fir type on national forest lands in California were reviewed. The characteristics of the type and the environment of the region in which it occurs were described along with their influence on management techniques. Some of the current practices and unsolved problems of regeneration, slash disposal, logging, etc., were discussed.

FS, USDA, Yreka, Calif.

200. Burton, J. D. TWENTY YEARS OF GROWTH IN THE NORRIS WATERSHED PLANTATIONS. J. Forestry 62(6): 392-397. 1964.

Examination of large-scale 20-year-old experimental plantations, established on eroding old fields near Norris, Tenn., indicated that shortleaf and eastern white pines had survived and grown very satisfactorily. Yellow-poplar planted in pure stands survived and grew acceptably; on the best sites it outgrew the pines; on poor sites its diameter increment was disappointing. Survival of white ash and baldcypress was fair to good, but after 20 years the trees were still in the seedling and sapling stages. Admixture by double rows with black locust had no effect on shortleaf pine but apparently stimulated height and diameter growth of yellow-poplar. Of various mixtures in groups, only sweetgum with yellow-poplar appeared satisfactory. Establishment and initial survival of seeded and planted upland oaks and seeded black walnut were very good, but nearly all trees were destroyed by rodents during the first 5 years. Growth of some surviving individuals was fair on average sites and remarkable in sinkholes, suggesting that the biggest problem in the artificial regeneration of these species in this locality is protection from mammalian depredation.

Silviculture Lab., Southern Forest Expt. Sta., FS, USDA, Sewanee, Tenn.

201. Winjum, J. K., and Johnson, N. E. DIFFERENCES IN CONE NUMBERS, LENGTHS, AND CUT-COUNTS IN THE CROWNS OF YOUNG OPEN-GROWN DOUGLAS-FIR. J. Forestry 62(6): 389-391. 1964.

Twenty open-grown Douglas-fir (Pseudotsuga menziesii [Mirb.] Franco), between 10 and 39 years old, were studied in 1961 for the distribution of cones and branches. The trees were widely distributed throughout western Oregon and Washington and had individual crops ranging from 151 to 6,000 cones. Cone-bearing portions of the crowns were divided into thirds vertically and into N, E, S, W quarters radially. The cones and branches in each of the 12 portions were counted and two cones from each were sliced and a "cut-count" made. Cone numbers, lengths, and cut-counts were greatest at the distal position on the branches in the upper and middle south portions of the crown. Internodal branches accounted for 9.1 percent of the cone crop and generally had shorter cones; the latter had lower cut-counts than did cones of the whorl branches.

Forestry Res. Cent., Weyerhaeuser, Co., Centralia, Wash.

202. Hermann, R. K. EFFECTS OF PROLONGED EXPOSURE OF ROOTS ON SURVIVAL OF 2-0 DOUGLAS-FIR SEEDLINGS. J. Forestry 62(6): 401-403. 1964.

Roots of 2-0 Douglas-fir seedlings were exposed under controlled conditions of temperature and humidity for periods ranging from 5 to 120 minutes prior to planting. Adverse effects of exposure were found to vary with time of lifting and length of storage. Trees lifted in winter withstood longer exposures than did trees lifted in fall or spring. Extending storage appeared to increase susceptibility to exposure. With one exception, gain in weight of surviving seedlings was reduced markedly by exposures beyond 30 minutes.

Forest Res. Lab., Oreg. State U., Corvallis, Oreg.

203. Allen, R. M. CONTRIBUTIONS OF ROOTS, STEMS, AND LEAVES TO HEIGHT GROWTH OF LONGLEAF PINE. Forest Sci. 10(1): 14-16. 1964.

Pinus palustris Mill. saplings made 31 percent of their normal spring elongation from food reserves in the woody stem. The roots supplied materials for an additional 15 percent when the old needles were present or 29 percent in their absence. The old needles apparently furnished enough materials for 40 percent of normal elongation, but this was increased to 54 percent when the roots were partially isolated from the top by girdling.

Inst. Forest Genetics, Southern Forest Expt. Sta., FS, USDA, Gulfport, Miss.

204. Bassett, J. R. TREE GROWTH AS AFFECTED BY SOIL MOISTURE AVAILABILITY. Soil Sci. Soc. Amer. Proc. 28(3): 436-438. 1964.

Merchantable volume growth in a managed southern pine forest was measured every 3 years from 1940-60. Available soil moisture in the surface foot was estimated for each day of the 21 growing seasons. The soil-moisture estimates were combined with estimates of potential evapotranspiration to calculate indexes of potential growth. Linear regressions of measured growth on calculated potential growth explained 95 to 97 percent of the variation about the regression lines. With sufficient soils information and past measurements of growth, foresters may be able to estimate current annual growth in timber stands.

Timber Mangt. Lab., Southern Forest Expt. Sta., FS, USDA, Corsett, Ark.

205. Vaartaja, O. CHEMICAL TREATMENT OF SEEDBEDS TO CONTROL NURSERY DISEASES. Bot. Rev. 30(1): 1-91. 1964.

Review of many empirical trials and theoretical investigations on the fate and action of antifungal chemicals in soil gave some promise of success for chemical treatment of seedbeds to control nursery diseases. A few of the new organic compounds, especially captan, thiram, zineb, and possibly Ceredon, Dexon, Dyrone, and Omedines should be expected to exert useful control of pathogenic soil fungi. Inexpensive seed treatments may suffice whenever the disease risk is not severe, especially if applied with the addition of a sticker. In more serious cases, repeated applications to seedbeds are preferable, perhaps in addition to seed treatments. These fungitoxicants can often inhibit a very tolerant pathogen without undue damage to the seeds and seedlings. Under unfavorable conditions, control may fail, even with the best fungitoxins. Success often depends on help from biological control often resulting from the selective action of these compounds. The difficulty is to know the right dosages for different soils and how often to repeat the applications for any weather condition. Much basic research, especially on the biology of pathogens and antagonists in soil, and local experience are needed before the potentialities of these new fungitoxicants can be fully utilized.

The idea of combining several compounds, either in the same applications or by alternation in successive years, seems worthy of trial. Care should be taken that one compound does not nullify the useful selectivity of another.

Although some of the new fungitoxicants are promising, our knowledge of their action in soil is meager and increasing slowly. Therefore, no laxity in cultural and sanitation methods should be allowed. Care should be taken not to increase the disease through unfavorable microbiological changes after applications of insecticides, herbicides, or fungicides. With increasing mechanization in nurseries, the seedbed stage is omitted and seeds are sown by machines directly in the rows. With this change, trials should be made for the practice of treating the covering soil with fungitoxicants to give better and more prolonged control than seed treatments. The

control can perhaps be further prolonged by applying fungitoxicants with known long life in soil (captan, Dexon, zineb) and granular or coarse formulations.

Where diseases are caused by unusual organisms, some of the nemacides or soil sterilization by fumigants should be tried. Methyl bromide, Vapam, Mylone, and sometimes allyl alcohol, are suitable for this. Sterilization should be followed by seed or soil treatments with protectants of low phytotoxicity or by strict sanitation practice.

New promising protectants, including antibiotics and chemotherapeutants, need to be screened and tried under various conditions. The ideal soil fungicide has yet to be discovered.

Bibliography of 662 papers.

Forest Path. Lab., Saskatoon, Saskatchewan, Canada.

206. Becker, W. B. AUTUMN VERSUS SPRING SPRAYING TO COMBAT INSECT PESTS OF UNSEASONED PINE LOGS. J. Forestry 62(6): 386-388. 1964.

An 11.7 percent gamma isomer content BHC emulsifiable liquid concentrate was diluted in water to 0.4 percent gamma content, by volume, and applied to live, standing pine (Pinus strobus L.) trees in the autumn or spring. The trees were subsequently felled.

Applications with a small sprayer at either season gave 94.4 to 100 percent protection the following summer against pine sawyer beetles (Monochamus spp. [Cerambycidae]) on well sprayed lower trunks. Protection decreased in the higher parts of the trunks which were less heavily sprayed. However, such decreases were slight on spring-sprayed-and-felled trunks and much more on all autumn-sprayed trunks. This reflects the effect of overwinter weathering on the BHC residue. Protection was slightly better on upper portions of autumn-sprayed-and-felled trunks. This suggests overwinter seasoning of logs may help make them slightly less attractive to Monochamus spp.

Protection against pine bark bettles (Scolytidae) followed the same general trends observed for pine sawyer beetles. Other insect pests of unseasoned pine logs were just as scarce in the well sprayed, lower trunks.

U. Mass., Amherst, Mass.

207. Miller, R. K. TWO AIDS FOR THE DESIGN OF FOREST ROADS. J. Forestry 62(6): 381-385. 1964.

The proper location of a forest road depends on the requirements it must meet to fit into the over-all management plan of the forest area and on the topography it must traverse. Every forest road should be designed to do the job required of it after it has been built for the least cost possible.

Intensive reconnaissance prior to traversing the proposed road location cannot be overemphasized as the first vital step in the location process. This reconnaissance should include: The noting of potential trouble spots to stay away from; control points such as saddles, landings, creek crossings, and benches; rough grades; and alignment necessary to build the road in its proper location.

The second step in the location process is the preliminary traverse of the proposed location. This traverse should be detailed enough to give the forester-engineer the necessary information to adequately design the final road. The notes of this traverse should include: Accurate side slope shots; the bearings, gradient, and size of creeks that are crossed; and information to allow the plotting of the profile of the traverse.

The preliminary traverse information, the Centerline Design Aid, and the Culvert Length Finder (described), can make the problem of designing the best forest road an easier one for the forester-engineer.

Navajo Forest Products Indus., Navajo, N. Mex.

Windbreaks

SEE ALSO 128, 169.

208. Read, R. A. TREE WINDBREAKS FOR THE CENTRAL GREAT PLAINS. U.S. Dept. Agr. Handbook 250, 68 pp. 1964.

What is known about the influences and values of windbreaks was summarized and practical recommendations for the planting and care of tree windbreaks in the central Great Plains were given. The area includes Nebraska, Kansas, eastern Colorado, and southern South Dakota.

Photographs, charts, and tables.

FS, USDA, Inform. Div., Washington, D.C., 20250

Management of Coffee Plantations

209. Singh-Dhaliwal, T., Lopez-Rosa, J. H., Steiner, G., Igaravídez, L., and Torres-Sepúlveda, A. STUDIES OF COFFEE ROOT ROT AND HORTICULTURAL PRACTICES FOR ITS AMELIORATION. Puerto Rico Agr. Expt. Sta. Tech. P. 36, 30 pp. 1963.

Root rot disease caused by the fungus, Fusarium oxysporum f. coffeae (F. bulbigenum var. coffeae (Alvarez G.) Wellm.) severely affects the Arabica-type coffees, Puerto Rican, Columnaris, and Bourbon, commonly grown in Puerto Rico.

The leaves of the diseased coffee trees suddenly start yellowing and wilting. Usually within a few weeks they are shed and the whole tree dries up. Generally the cortex of the lower part of the stem and roots of the diseased tree deteriorates. There is vascular discoloration in undeteriorated or partly deteriorated wood.

The Fusarium isolates from diseased coffee trees collected from different parts of the Coffee Region varied morphologically, indicating possible genetic variability.

A large number of coffee species, varieties, selections, and their hybrids were tested for resistance to the root rot disease by inoculating them with the pathogen under greenhouse conditions, and also by planting them in naturally contaminated fields. Some of them showed tolerance to the disease.

In fields naturally contaminated with the root rot fungus, Puerto Rican and Bourbon trees with Excelsa (Coffea excelsa) and Robusta (C. canephora) rootstocks suffered less than ungrafted Puerto Rican and Bourbon trees.

There was severe incidence of coffee root rot disease on soils varying in pH from 3.89 to 7.60.

In root and soil samples from the coffee trees severely infected with the root rot disease, parasitic nematodes species of several genera, such as Pratylenchus, Meloidogyne, Longidorus, Helicotylenchus, and Tylenchus were identified. Consequently, most of diseased coffee trees also suffered from the attack of parasitic nematodes. It appears that parasitic nematodes render coffee trees more vulnerable to Fusarium.

Losses from coffee root rot disease can be prevented or reduced through careful use of measures such as: (1) Destruction of diseased coffee trees and other vegetation; (2) the use of disease-free planting material; (3) planting a large number of coffee trees per acre; (4) the use of resistant coffee varieties; (5) the use of resistant

coffee rootstock; (6) avoiding injury to roots and stems of coffee trees; and (7) following crop rotation when necessary.

U. Puerto Rico, Agr. Expt. Sta., Rio Piedras, Puerto, Rico.

Fruit and Nut Crops

SEE ALSO 94, 141, 150, 283, 292.

210. Fry, B. O. VARIETY AND CULTURAL STUDIES WITH BLACKBERRIES AND DEWBERRIES. Ga. Agr. Expt. Sta. Mimeo, Ser. N. S. 202, 13 pp. 1964.

The Youngberry and Boysenberry were the best dewberry varieties tested for Georgia. The Boysenberry fruit was firmer than other recommended varieties and the Youngberry fruit had the best flavor. The Flint and Early June blackberries were the highest yielding blackberry varieties and both ripened their fruit soon after the dewberry season.

The two-wire vertical trellis was usually preferred for blackberries and dewberries to other methods of training. It was less expensive to establish and maintain and more economical yields usually were obtained than from the three-wire horizontal trellis. The stake method of training resulted in lower yields than either the two or three-wire trellis.

The use of Bordeaux mixture and Dithane for the control of anthracnose and leaf spot resulted in no increased yields of Boysenberries when compared to check plots. In some years, when there was a heavy infestation of pear psylla, red-necked cane borer, and red spider, spray applications of malathion and DDT resulted in good control.

Satisfactory weed control in blackberry plantings was obtained with pre-emergence applications of 2 and 4 lb./A. of simazine with no apparent injury to blackberry plants. However, where there was a heavy infestation of morning glory and ragweeds, the higher rate was the most effective in controlling these weeds. Atrazine gave good control of weeds at 5 lb./A. but some plant injury occurred when the herbicide came in contact with the blackberry leaves.

Blackberry plants may be produced commercially by rooting cuttings under mist spray. The cuttings taken in late spring and summer will root and be ready to be set in nursery rows in approximately 35 days.

Ga. Agr. Expt. Sta., Athens, Ga.

211. Savage, E. F., Hayden, R. A., and Ward, W. E. THE EFFECT OF TYPE AND SEASON OF PRUNING ON GROWTH AND YIELD OF DIXIGEM PEACH TREES. Ga. Agr. Expt. Sta. B. N. S. 109, 18 pp. 1963.

Studies were conducted with the Dixigem peach to compare vase-shaped and modified leader types of pruning with respect to yield and tree growth. The effects of pruning in summer and in winter were also studied.

In comparing vase-shape and modified leader pruning types, yields, fruit size, and tree growth were essentially the same. However, the prunings removed from the vase-shaped trees averaged 33.9 percent heavier than those from modified leader trees. Therefore, the labor requirement to maintain vase-shaped trees was considerably higher. Modified leader trees have less horizontal scaffold limbs and thus were less subject to damage from low temperature.

The summer-pruned trees tended to be somewhat dwarfed, producing smaller trees with smaller trunk circumferences and smaller volumes. Fruit size also was smaller in summer-pruned trees. In 1948 and 1949, the first 2 years of bearing after summer pruning was started, the summer-pruned trees averaged 17.6 pounds more fruit per tree per year than the winter-pruned trees. In 1951-53, the production of fruit was

about equal. In the last four bearing years, the winter-pruned trees averaged 29.9 pounds per tree per year more than the summer-pruned trees. Thus summer pruning, in long-lived orchards at least, reduced size of trees and yields appreciably. It was also more difficult to prune trees while in leaf, although the practice sometimes used the labor supply more advantageously. Summer-pruned trees were more susceptible to cold injury.

Ga. Agr. Expt. Sta., Athens, Ga.

212. Hill, J. S. A STATISTICAL HANDBOOK FOR THE DESERT GRAPEFRUIT INDUSTRY. Ariz. Agr. Expt. Sta. Rpt. 220, 54 pp. 1964.

A compilation of current, historical, and graphic data pertaining to the Arizona-California Desert Grapefruit Industry was presented along with additional figures relative to the industry in other producing areas of the United States. This statistical material was intended to serve as a reference for the industry. This was a cooperative report.

Tables and graphs.

Ariz. Expt. Sta., U. Ariz., Tucson, Ariz.

213. Hield, H. Z., Burns, R. M., and Coggins, C. W., Jr. PRE-HARVEST USE OF 2,4-D ON CITRUS. Calif. Agr. Expt. Sta. Ext. Serv. C. 528, 10 pp. 1964.

Plant growth regulators such as 2,4-D cause a change in normal plant processes when used in small amounts. In citrus spraying, the type of 2,4-D used is of vital importance as there are many types marketed for weed killing and some of them will cause damage to citrus at concentrations used for growth regulator purposes. The only form of 2,4-D which should be applied to citrus in California is the high-volatile ester, which is labeled as a citrus growth regulator.

When properly used, 2,4-D can reduce pre-harvest fruit drop, increase fruit size, reduce leaf and fruit drop following pesticide oil sprays, and lessen fruit stem die-back.

Ways to use 2,4-D on citrus were given.

Agr. Pub., U. Hall, U. Calif., Davis, Calif.

214. Farris, D. E., and Allen, E. J. PECAN PRODUCTION IN ARKANSAS. Ark. Agr. Expt. Sta. B. 680, 25 pp. 1964.

Opportunities exist for increased income from pecan production through improvements in production and marketing practices.

Establishing new pecan groves involves long-term investments. The information presented was designed primarily to assist in evaluating the long-term opportunities for this crop.

Pecan production is becoming an important specialized enterprise on a limited number of farms in Arkansas. Among 56 farmers contacted, 31 producers reported pecans comprised an average of 38 percent of the gross farm income.

During the last 10 years, improved pecan prices in Arkansas averaged 28.7 cents per pound. The estimated annual cost of production for 10 selected growers was 10 cents per pound, not including a charge for land or interest. When these charges were made, the cost per pound was 21 cents, leaving a net return to management of almost 8 cents per pound.

Estimated costs and returns were calculated, based on recommended practices and experimental results. Harvest from a grove should pay for the cost of establishing and maintenance (including a land rental charge) in 15 years. After this time, a return to management and capital of \$68.64 per acre from the 16th to the 20th year and \$38.57 from the 21st year on was estimated. This was based on a rental value of \$20.00 per acre for the land, a yield of 600 pounds per acre, a harvesting and selling charge of 5 cents per pound, and a selling price of 25 cents per pound. The annual cost of production after the 21st year (including a land charge of \$20.00 per acre) was estimated at 13.6 cents per pound. This, plus the 5-cent harvesting and selling charge would give a total cost of 18.6 cents per pound. Deducting this cost per pound from the assumed selling price of 25 cents gives a net return of 6.4 cents per pound.

Agr. Expt. Sta., Div. Agr., U. Ark., Fayetteville, Ark.

215. Jones, R. E., and Danner, M. J. FARM HANDLING AND MARKETING OF PECANS IN ALABAMA. Ala. Agr. Expt. Sta. C. 148, 19 pp. 1964.

For a period of 16 years, pecan production in Alabama has followed a pattern that has allowed for no more than two larger-than-average crops out of any 5-year period.

Apparent factors that have contributed to this pattern include: (1) A shortage of plant food; (2) adverse climatic conditions; (3) the nature of the pecan tree; (4) diseases and insects; or (5) a combination of these and other related factors.

More than 60 percent of the growers in the sample had fewer than 200 trees; 17 percent had 400 trees or more; and only 5 percent reported a thousand or more. The 10 largest growers in the sample produced over a third of the total production recorded.

The Stuart variety was grown by 97 percent of the growers and accounted for 67 percent of the trees. Stuart, Success, Schley, and seedlings accounted for 90 percent of the total trees.

The only disease reported to be of significant importance was pecan scab. Disease and insect spray programs were used principally by larger growers.

Pecan gathering was chiefly a hand labor operation. Less than 3 percent of the growers stored pecans for periods longer than a month. Pecans were usually sold within 48 hours of harvest.

Pecan marketing at the grower level was usually a matter of selling to local dealers. Retail sales accounted for less than 1 percent of the pecans sold.

Marketing procedures were simple and unorganized and lack of grading offered little incentive for growers to stress quality.

Despite gradual decreases in the total number of trees in the State since 1945, average annual production has continued to increase.

Agr. Expt. Sta., Auburn U., Auburn, Ala.

Field Crops

SEE ALSO 28; 61, 72, 82, 83, 90, 96, 99, 100, 101, 103, 107, 138, 140, 141, 142, 145, 151, 153, 154, 159, 163, 164, 165, 166, 168, 173, 174, 175, 180, 187, 188, 189, 191, 195, 237, 238, 265, 281, 282, 291, 296, 297.

216. Hughes, C. EFFECTS OF PLANTING DATES AND SPACINGS ON COTTON. Ark. Agr. Expt. Sta. Rpt. Series 126, 14 pp. 1964.

Three planting dates and three stand spacings were incorporated into a test conducted for 4 years at Marianna, Ark., on a soil type classified as Loring sil. Rex cotton was used.

Four year averages indicated that on this type soil, April planting dates give highest yields, and when planting was made in April thick stands were desirable. If planting was delayed until May or later, hilldropped stands were more efficient.

Crossplowed stands produced larger bolls and longer fibers. Fiber length also was increased by delay in planting.

Agr. Expt. Sta., Div. Agr., U. Ark., Fayetteville, Ark.

217. Tugwell, N. P., and Waddle, B. A. YIELD AND LINT QUALITY OF COTTON AS AFFECTED BY VARIED PRODUCTION PRACTICES. Ark. Agr. Expt. Sta. B. 682, 44 pp. 1964.

Two levels each of insecticides, irrigation, fertilizers, varieties, and spacings were compared in all combinations on a Perry sil soil at Rohwer, Ark., during 1960-62. One level of each treatment approximated that recommended by the Arkansas Agricultural Extension Service and the other level of insecticides, irrigation, and fertilizers was higher (supra-optimal) than now recommended.

Yield was not increased above that to be expected when the currently recommended practices were followed. Within this yield range, the Rex variety responded more consistently to the conditions of this test and was superior to Deltapine 15 each year in total yield and maturation. Irrigation, applied in 1960 and 1962, increased total yield but it delayed maturation in 1962. Maturation also was reduced by the single spacing treatment.

Treatment interactions indicated that the varieties responded differently to spacing, insecticidal timing, and insecticidal timing plus irrigation in special combinations. Deltapine 15 appeared to be adversely affected by those of the above-mentioned treatments that prolonged the indeterminate growth type of Deltapine 15; the opposite was indicated for Rex.

Thrips damage symptoms ranged from medium to heavy for the Deltapine 15 variety in 1960 and a delay in fruit development was associated with this damage. Thrips counts reached an average high of 5.2 per plant in 1960. Rex was not damaged although it carried as high a thrips population as did Deltapine 15.

Except for the cotton bollworm, all insect populations were, in general, low for the 3-year period. The bollworm was potentially dangerous each year and tended to be more of a problem in the "fixed" schedule insecticide treatment. In 1962, aphids were linked with a bollworm buildup in the "fixed" schedule plots.

Unlike the bollworm problem, boll weevil populations were suppressed in the "fixed" schedule plots, although the weevil did not reach high proportions in either insecticide treatment.

Plant bug populations were low each year.

Aphid and spider mite populations were suppressed with the addition of methyl parathion to toxaphene-DDT which was used to control other pests and, with the one exception where aphids were linked with the 1962 bollworm buildup, these pests were not a problem.

Beneficial insect counts were made for lady beetles, big-eye bugs, insidious flower bugs, nabids, and lacewings. These insects decreased as the season progressed in both insecticide treatments but appeared to do so at a faster rate in the "fixed" schedule plots.

Insect populations appeared not to be affected by the agronomic treatments. Although the full irrigation treatment increased plant height, insecticide coverage was not affected adversely. On the other hand, the insecticide itself appeared to have a direct effect on the cotton plant.

Of the factors resulting in fruit loss, insects played only a minor role. Boll load and environmental influences were associated with up to 94.4 percent of boll loss.

Fiber properties were not substantially altered by any treatment or treatment combination other than variety. In 1961 and 1962, weekly samples revealed a decrease in quality of the cotton fiber after the third or fourth week as a consequence of factors other than those controlled in this experiment.

Agr. Expt. Sta., Div. Agr., U. Ark., Fayetteville, Ark.

218. Douglas, A. G., Brooks, O. L., and Farshtchi, D. VARIETY, SPACING AND MECHANICAL HARVESTING OF COTTON AT THE SOUTHEAST GEORGIA BRANCH EXPERIMENT STATION MIDVILLE, GEORGIA. Ga. Agr. Expt. Sta. B. N. S. 117, 25 pp. 1964.

Mechanization of the cotton harvest has increased rapidly in Georgia in the past 10 years. An experiment was conducted for 3 years to evaluate the adaptation of four varieties and four spacings for mechanical harvesting, and to determine the effects of mechanical harvesting on yield and on several quality traits of the harvested product.

Lint production was affected by variety, population, and method of harvest. Auburn 56, at the rate of 30,000 plants per acre and hand harvested, gave the highest yields.

Boll size was affected by variety and population, with Empire WR, Dixie King, and low populations producing the larger bolls.

None of the variables studied had any effect on lint percent.

Only variety had an effect on upper half mean length of fiber, with Coker 100A producing fiber with a longer upper half mean than the other varieties. Mean length of fiber and uniformity ratio were affected by population and method of harvest. Hand harvesting and 10,000 plants per acre produced fiber with the longest mean length and the highest uniformity ratio. Fiber strength was not affected by any treatment.

Even though hand harvesting produced more lint per acre, higher net returns to land and management were realized with mechanical harvesting.

Germination of seed harvested from the plots was affected by variety, population, method of harvest, and germination temperature. Seed from Coker 100A and Auburn 56 at low plant populations gave highest germination percent. Hand harvesting and high temperatures also produced high germination percents.

Ga. Agr. Expt. Sta., Athens, Ga.

219. Waddle, B. A. EFFECT OF EARLY SEASON PRACTICES ON THE GROWTH AND YIELD OF COTTON IN JEFFERSON COUNTY, 1962. Ark. Agr. Expt. Sta. Spec. Rpt. 14, 38 pp. 1964.

A multiple factor experiment involving 32 treatment combinations was conducted at five locations in Jefferson County, Ark., in 1962. Two levels each of varieties, boron, pre-emergence herbicides, seedling application of insecticides, and fungicides were compared alone and in all possible combinations to give the 32 treatments. The author concluded that:

1. The Rex variety, when compared to Deltapine Smooth Leaf, generally had fewer seedlings die, especially at the Rainey site; fewer tomotic plants when no insecticide was used at the Bishop and Pack sites; fewer leaves at squaring time at the Rainey site; shorter plants at squaring time at the Swindle and Rainey sites; higher yields at first picking at the Rainey and Elms sites but lower yields at the Swindle site (the yield differences were not statistically significant); and lower fiber strength in the absence of boron and longer elongation indices in all plots tested.
2. The use of banded boron as a pre-emergence application had no effect on stands except where some stand reduction was associated with herbicides and then only in the Rex variety; increased seedling mortality at the Pack site (from 0.02 to 0.13 percent); reduced the frequency of tomotic plants at the Swindle site and in the plots of the Deltapine Smooth Leaf variety receiving herbicides at the Elms site; increased yields at first harvest at the Swindle and Elms sites; increased total yields of Rex receiving seedling insecticides at the Swindle site; and increased the fiber strength of Rex at the Swindle site.

3. The use of diuron as a band application of pre-emergence herbicide had no effect on initial stands or seedling mortality; increased the frequency of tomotic plants at the Bishop and Rainey sites, the Deltapine Smooth Leaf plots receiving no boron at the Elms site, and the plots receiving both seedling insecticide and fungicide at the Bishop and Swindle sites; and had no effect on yield and fiber properties.
4. The use of three applications of seedling insecticide had no effects on initial stands or seedling mortality; significantly reduced the frequency of tomotic plants; may have increased leaf count at squaring time at the Rainey site; had no effect on any type of terminal abortion; decreased yield at first harvest at the Rainey site and increased earliness at the Bishop plots on plants of the Deltapine Smooth Leaf variety; and had no effect on total yield except in a special case at the Swindle site.
5. The use of "Soil Treater X" as a hopper-box fungicide treatment reduced initial stands; lowered seedling mortality at the Rainey, Bishop, and Pack sites; increased the frequency of tomotic plants at the Rainey and Pack sites; reduced leaf count at the Pack site and plant height at squaring time at the Rainey and Pack sites; and had no direct effect on yields or fiber properties.

Agr. Expt. Sta., U. Ark., Fayetteville, Ark.

220. Chaplin, J. F., Ford, Z. T., and Currin, R. E. SOME EFFECTS OF TOPPING HEIGHTS AND SUCKERING FLUE-CURED TOBACCO. S.C. Agr. Expt. Sta. B. 510, 10 pp. 1964.

Topping heights and suckering practices in flue-cured tobacco, were studied at the Pee Dee Experiment Station in Florence, S.C. In 1961-62 four flue-cured varieties of tobacco were topped at three different heights based on the number of leaves. In 1961, the varieties were Hicks Broadleaf, NC 95, Coker 316, and 402, with 402 being replaced with McNair 12 in 1962. These were subjected to three topping treatments; low topping (16 leaves), medium topping (20 leaves), and high topping (as many leaves as produced). There was no significant increase in yield or value per acre from the medium topping to the high topping for any of the varieties. The low topping reduced yield and money value per acre.

The value per cwt. was lowest for high topping and highest for low topping. The percent total alkaloids was higher for the low topping and lower with the high topping. The topping heights had little effect on percent of reducing sugar.

A test was also conducted to compare topping and suckering, topping (no suckering), and no topping or suckering on Hicks Broadleaf tobacco. The highest yield and value per acre were obtained from the topped and suckered tobacco. There was an increase of 97 pounds and \$75 per acre by topping the tobacco even though it was not suckered. An increase of 416 pounds and \$295 per acre was obtained after the tobacco was topped and suckered over the control.

The tobacco that wasn't topped was too low in total alkaloids and reducing sugar to be commercially acceptable, but topped tobacco (whether suckered or not) was in the general range of acceptability for total alkaloids and reducing sugar.

Tables.

S.C. Agr. Expt. Sta., Clemson Col., Clemson, S.C.

221. Heyne, E. G., Smith, F. W., Hobbs, J. A., Stickler, F. C., Anderson, L. E., and Wilkins, H. D. GROWING WHEAT IN KANSAS. Kans. Agr. Expt. Sta. B. 463, 35 pp. 1964.

A "culture and care" publication on the growing of wheat in Kansas was given.

Agr. Expt. Sta., Kans. State U., Manhattan, Kans.

222. McManus, B. R., and White, M. PROCUREMENT OF CORN IN ALABAMA. Ala. Agr. Expt. Sta. B. 354, 39 pp. 1964.

Significant changes have taken place during recent years in Alabama's feed-grain and meat-producing industries. Specialization of enterprises and size of operations have increased. Production of livestock and poultry has increased while total production of corn in Alabama has remained about the same during the past decade.

The increasing difference between corn production and utilization in Alabama has focused attention on the movement of corn from surplus producing areas into Alabama.

Approximately 85 percent of all corn purchased by grain handlers in Alabama in 1959 and 1960 came from sources outside the State. Illinois, Iowa, Missouri, and Indiana were the leading sources of corn during both years.

Corn was imported into Alabama by barge, truck, and rail. Barges transported approximately 60 percent in 1959 and 80 percent in 1960. Major points for barge imports were along the Tennessee River at Guntersville, Decatur, and Sheffield. Imports by trucks direct from the Corn Belt went primarily into southern Alabama with a lesser amount going into central Alabama. Railroads were used to transport corn to Birmingham, Montgomery, Tuscaloosa, and other points where transit privileges were important.

Barge rates have been the lowest for moving corn between points where navigable waterways are available. In some cases where barge transportation was not available, barge-truck transportation was cheaper than other means. Truck transportation has been particularly effective for short distances and when backhauls of corn were made. Transit privileges granted by railroads have had a strong influence on the means of transportation selected for shipments of corn stored or processed enroute.

An analysis of prices in corn-deficit and corn-surplus areas indicated that deficit area prices have not been greater than the sum of surplus area prices and transfer charges.

For 1960-62, prices received by farmers in the major corn producing states averaged 10 to 17 cents per bushel less than prices quoted for No. 2 yellow corn, f.o.b. track, at the central market in respective states. Prices quoted for Guntersville-Decatur area and for Birmingham were 8 and 15 cents greater, respectively, than prices received by farmers in northern Alabama.

Seasonal variation in prices received by farmers was approximately the same for major corn producing states and Alabama. Prices at peak harvest, however, were more depressed in the Corn Belt than in Alabama.

Imported corn was available as shelled corn throughout the year in adequate quantities; whereas, locally produced corn was available primarily as ear corn during harvest season. Imported corn was for sale through established, organized markets and locally produced corn was for sale at random points.

Estimated procurement prices at selected points in Alabama indicated that Minneapolis was consistently the least-cost source of corn during April through December. Kansas City, Omaha, Chicago, or St. Louis provided the least-cost source of corn during January, February, and March.

The major advantage of purchasing locally produced corn was that good quality ear corn could have been bought during the harvest period for less than imported shelled corn.

An outstanding advantage of purchasing imported corn was that graded, shelled corn was available in adequate quantities throughout the year.

Alabama is expected to continue to be a corn-deficit area. Corn will be imported in increasing amounts from surplus producing areas in the Midwest.

In situations where ear corn is desired and adequate storage facilities are available, users of locally produced corn can profit by making purchases during the harvest season.

Agr. Expt. Sta., Auburn U., Auburn, Ala.

223. Vergara, B. S., Lilis, R., and Tanaka, A. RELATIONSHIP BETWEEN LENGTH OF GROWING PERIOD AND YIELD OF RICE PLANTS UNDER A LIMITED NITROGEN SUPPLY. Soil Sci. and Plant Nutr. 10(2): 59-65. 1964.

The relationship between growth duration and grain yield, with nitrogen as a possible limiting factor, was determined by manipulating with photoperiods the growth duration of BPI-76, a photosensitive indica variety.

Maximum grain yield was obtained in plants with certain critical growth durations. Plants with a duration shorter than the critical duration produced fewer panicles and fewer spikelets per panicle. Plants with durations longer than the critical duration produced the same number of panicles as the maximum yielding plants, but formed fewer spikelets per panicle.

Short duration plants did not have enough growth period to produce a large number of panicles and sufficient leaf area. Adequate leaf area was necessary for the manufacture of assimilation products required for the development of a large number of spikelets in a panicle.

The long duration plants have time to produce many panicles, but limitations in nitrogen restricted the number of panicles. Also, low nitrogen content during the reproductive phase resulted in fewer spikelets per panicle.

Plants with well balanced nitrogen uptake in each phase of growth gave high yields. With large leaf area and adequate nitrogen, the plants manufactured a large amount of carbohydrates during the reproductive and ripening phases.

Internat'l. Rice Res. Inst., Los Banos, Laguna, Phillipines.

224. Culp, T. W. CHEMICAL DESICCATION OF CASTORBEANS IN THE SOUTHEAST. Agron J. 56(2): 226-228. 1964.

The proper time to desiccate and harvest several castorbean varieties for maximum yields was determined in 1961. Baker 296 produced excellent yields of 2969 to 3069 pounds of seed per acre when desiccated and harvested from September 28 through November 7 and satisfactory yields of over 2,000 pounds of seed per acre when desiccated and harvested from August 31 until November 17. Hale produced its highest yields of 2,829 and 2,653 pounds of seed per acre when desiccated and harvested from September 28 to October 24 and over 2,000 pounds of seed per acre were obtained by desiccating and harvesting from September 16 through November 7.

Similar tests were conducted at Greenwood, Hollandale, and Stoneville, Miss., in 1962. Yields were not as great during this season, but satisfactory yields of castorbeans were produced by harvesting in late September or October before diseases could destroy the crop.

CRD, ARS, USDA, Stoneville, Miss.

225. Hodgson, J. M., Thrasher, F. P., and Eslick, R. F. EFFECTS OF EIGHT HERBICIDES ON YIELDS OF BARLEY AND WHEAT VARIETIES. Crop Sci. 4(3): 307-310. 1964.

Twenty-two spring barley and twenty-two spring wheat varieties were sprayed early post-emergence with eight chemicals to evaluate their effect on yield.

Barley and wheat varieties varied widely for tolerance to herbicides between the most resistant and the most susceptible varieties. Barley varieties of the Smyrna type of parentage exhibited greater resistance to yield reduction by 2,4-D, MCPA, or barban than barley varieties of the non-Smyrna type such as Alpha, Charlottetown, Freja, and Heines Hanna.

Crim and a Thatcher X Rescue cross were more resistant to the wild oat herbicide barban than "Conley" or "Chinook".

Yields of some wheat and barley varieties were increased after treatment with the chemical DMPA indicating a stimulatory effect.

CRD, ARS, USDA, Montana State Col., Bozeman, Mont.

226. Frans, R. E., and Holifield, E. L. HERBICIDE FIELD EVALUATION TRIALS ON FIELD CROPS AND TURF, 1963. Ark. Agr. Expt. Sta. Mimeo Series 135, 25 pp. 1964.

Six primary field screening trials were reported on field crops and turf at the Main Experiment Station in Arkansas and seven secondary evaluations of herbicides were reported on cotton and soybeans at four branch stations.

In cotton, four experimental compounds, FW-925, swep, prometryne, and trifluralin, gave satisfactory weed control at least at one rate with no crop injury. A mixture of DCPA and CIPC also was promising. In secondary evaluations, trifluralin was satisfactory in one of three tests, the one test located on a clay soil. Monuron also produced satisfactory results on this soil. Several salt formulations of MAA were found to perform as well when used as a directed post-emergence treatment as did the standard, DMA.

In the primary test on soybeans, only linuron, prometryne, and swep produced satisfactory results when applied preemergence. Several mixtures of herbicides provided excellent weed control when delayed in application until soybean emergence. Damage to the crop was excessive, however. In the secondary evaluation NPA was effective in controlling cocklebur on a clay soil but was ineffective on coarser-textured soils. Linuron, amiben, and PCP were satisfactory at one silt loam location but somewhat less so at the other. None of the treatments were effective on the Gillion sands location.

In corn, the recommended herbicides atrazine and simazine gave excellent control with no turf injury when at least two applications were used.

Tables.

Agr. Expt. Sta., Div. Agr., U. Ark., Fayetteville, Ark.

227. Moolani, M. K., Knake, E. L., and Slife, F. W. COMPETITION OF SMOOTH PIGWEED WITH CORN AND SOYBEANS. Weeds 12(2): 126-128. 1964.

Yield reductions from the heaviest stand of smooth pigweed (Amaranthus hybridus L.) averaged 39 percent for corn and 55 percent for soybeans. For corn the increase in pigweed dry matter about equalled the decrease in the dry matter from the crop; the total dry matter yield was relatively constant. Pigweeds grew taller than soybeans, and the dry weight of crop plus pigweeds was 1-1/3 times that of weed-free soybeans.

As stand of pigweeds were increased, there was a decrease in yield of grain, cobs, and stalks or straw, diameter of cornstalks, height of crop, and soybean pods per plant. Yield reductions emphasized the importance of both chemical and cultural measures for reducing competition between row crops and weeds.

Indian Inst. Tech., Kharagpur, India.

228. Staniforth, D. W., and Lovely, W. G. PREEMERGENCE HERBICIDES IN CORN PRODUCTION. Weeds 12(2): 131-133. 1964.

Band applications of residual preemergence herbicides were equal to timely shallow cultivations for the control of annual weeds in corn, and were superior when wet weather delayed or interfered with early shallow cultivations. The average corn yield reduction of 7.4 bushels per acre from weed competition observed over a 13 year period, suggested that under average conditions the net cost of herbicide treatment would be less than the value of corn lost through failure to control weeds.

Iowa Agr. Expt. Sta., Iowa State U. Sci. and Tech., Ames, Iowa.

229. Burnside, O. C., and Colville, W. L. SOYBEAN AND WEED YIELDS AS AFFECTED BY IRRIGATION, ROW SPACING, TILLAGE, AND AMIBEN. Weeds 12(2): 109-112. 1964.

Ford soybean yields and weed yields were studied under combinations of tillage treatments, amiben applications, hand weedings, and row spacings on irrigated and non-irrigated locations in Nebraska during 1961-62. Soybean yields increased and weed yields decreased with tillage, amiben applications, hand weedings, and narrow-row spacing of soybeans. Combinations of these weed control treatments gave more dependable results than any one alone. Each 86 lb./A. of weeds present produced an average soybean yield reduction of 1 bu./A. Advantages of growing soybeans with amiben applications in 10-inch rows as compared to 40-inch rows were: (1) An average soybean yield increase of 39 percent; (2) elimination or reduction of tillage; (3) a 50 to 75 percent reduction in amiben application rate; and (4) little or no soybean injury from the lower rates of amiben required in the 10-inch rows.

U. Nebr., Lincoln, Nebr.

230. Stanley, J. M., Lawson, F. R., and Gentry, C. R. AREA CONTROL OF TOBACCO INSECTS WITH BLACKLIGHT RADIATION. Trans. ASAE 7(2): 125-127. 1964.

The experimental design, traps used, radiant attractant, and general results of a 1962 experiment using blacklight radiation was given.

The hornworm moth populations were reduced by use of electric insect traps when installed at a density of 3 per square mile over an area at least 12 miles in diameter. The effect of the light traps was not the same for the two species. The highest estimated reduction was 89 percent for male tomato hornworm moths. From this level, the estimate ranged to 55 percent for female tobacco hornworm moths. A similar degree of reduction was observed on eggs and first-instar hornworm larvae on tobacco plants. Additional data are needed before recommendations on use of light traps can be made.

The equipment provided an excellent method of studying moth movements. Hornworm moths moved rapidly with some traveling more than 6 miles. The halflife of moths varied from 1.1 to 2.7 days, depending on species and sex.

AERD, ARS, USDA, Oxford, N.C.

231. Lyle, J. A., and Gudauskas, R. T. DISEASES OF SMALL GAINS IN ALABAMA. Ala. Agr. Expt. Sta. C. 147, 23 pp. 1964.

Diseases are often the greatest single factor limiting forage and grain production of cereal crops.

Many diseases can be controlled by chemical seed treatment, use of resistant varieties, crop rotation, and field sanitation. Identification of the disease involved is essential in selecting appropriate control measures.

Information obtained during the last decade from evaluations of disease incidence and varietal susceptibility of small grains planted in variety tests, field plots, and private farms throughout Alabama was given.

The various diseases were described and illustrated. Recommended control methods were given.

Agr. Expt. Sta., Auburn U., Auburn, Ala.

232. Chaplin, J. F. EFFECTS OF TOBACCO MOSAIC ON FLUE-CURED TOBACCO — RESISTANT AND SUSCEPTIBLE VARIETIES. S.C. Agr. Expt. Sta. B. 513, 7 pp. 1964.

Experiments were conducted in 1961-62 at the Pee Dee Experiment Station, Florence, S.C., to obtain information on the effects of mosaic disease on resistant and susceptible flue-cured varieties of tobacco when inoculated at various stages of growth. The varieties were M-40 (mosaic-resistant Hicks), Va. 45 (mosaic-resistant variety), and Hicks (susceptible). They were inoculated at transplanting time, when one-half grown, and at topping time and compared with controls not inoculated.

When Hicks was inoculated at transplanting or the one-half grown stage, reductions were: Yields 300 lb./A., price \$5.89 per cwt.; value \$263 per acre; and sugar content of cured leaf 4.97 percent. When Hicks was inoculated early (transplanting time), plant height was about 7 cm. less, internode length was about 0.7 cm. shorter than the controls, and flowering was delayed about 6 days. Mosaic did not affect the number of leaves per plant, suckers per plant, or percent total alkaloids. Mosaic did not affect any of the characters studied for the resistant varieties.

A yield depression was associated with mosaic resistance under disease-free conditions. However, if the mosaic infection starts early or in plants one-half grown, it would be an economic advantage to grow a resistant variety such as M-40. Va. 45 was no better than Hicks even when the plants became mosaic when one-half grown. Late mosaic inoculation (topping time) had no apparent effect on any of the characters studies.

These data were based on uniform inoculation of the field.

Tables.

S.C. Agr. Expt. Sta., Clemson Col., Clemson, S.C.

Vegetable Crops

SEE ALSO 27, 71, 82, 89, 106, 110, 141, 146, 266, 283, 292, 298.

233. Hayden, A. J. MAXIMIZATION OF PROFITS THROUGH PLANNING, TIMELINESS AND FULL UTILIZATION OF PROPERLY SIZED EQUIPMENT IN VEGETABLE PRODUCTION AS IT MIGHT APPLY TO OTHER AREAS OF AGRICULTURAL PRODUCTION. J. Amer. Soc. Farm Managers and Rural Appraisers. 28(1): 20-26. 1964.

A report on the use of modern business techniques, scientific knowledge, and mechanical innovations by a vegetable canning company was given along with recommendations as to how it might apply to other areas of agricultural production.

Proper planning at all times was stressed. The use of the heat unit system in scheduling all phases of vegetable production from planting through harvest was stressed along with the use of historical climatological data, weather forecast data, soil sampling, etc.

Up to forty factors are recorded for each and every field that is grown for the company. From this information various computer analyses can be made on hundreds of thousands of acres to obtain information by territory, field, time of season, and variety. The optimum planting dates, varieties, fertilizer additions, weed treatment, and many other factors leading toward higher profits can then be determined.

Green Giant Co., Le Sueur, Minn.

234. Talbert, R. E. HERBICIDE FIELD EVALUATION TRIALS ON VEGETABLE CROPS, 1963. Ark. Agr. Expt. Sta., Mimeo. Series 134, 10 pp. 1964.

An intensified program for the evaluation of herbicides in vegetable crops was initiated in 1963. Field trials were conducted on snapbeans, southern peas, sweet potatoes, and on direct-seeded and transplanted tomatoes. These studies were conducted at the Main Experiment Station, Fayetteville, Ark. The soil type is a complex of Taloka-Parsons-Johnsburg s1. In all tests, one-row plots 30 feet long, randomized complete block designs, and four replications were used. The experimental areas were overseeded with pigweed and crabgrass after the crop was planted or just before transplanting, then rolled, and then sprayed. All crops were planted at near optimum dates.

The following were the most promising treatments for selective weed control in various vegetable crops, based on the field experiments:

1. Direct-seeded tomatoes — diphenamid at 5 lb./A. preemergence and PEBC at 4 lb./A. preplant, incorporated.
2. Transplanted tomatoes — diphenamid at 5 lb./A. post transplant, dinoben at 6 lb./A. post transplant, PEBC at 4 lb./A. preplant incorporated, and trifluralin at 1.5 lb./A. preplant, incorporated.
3. Snapbeans — amiben at 3 lb./A. preemergence, diphenamid at 5 lb./A. preemergence, and trifluralin at 1.5 lb./A. preemergence, incorporated.
4. Southern peas — EPTC at 3 lb./A. preemergence, incorporated; trifluralin at 1.5 lb./A. preemergence, incorporated; sycluron at 1.8 lb./A. plus CIPC at 1.2 lb./A. preemergence; diphenamid at 5 lb./A. preemergence; linuron at 1 to 2 lb./A. preemergence; and sodium salt of PCP at 20 lb./A. preemergence.
5. Sweet potatoes — EPTC at 7.5 lb./A. post transplant; EPTC at 3 lb./A. preplant, incorporated; amiben at 3 lb./A. post transplant; diphenamid at 5 lb./A. post transplant; and norea at 2 lb./A. post transplant.

Agr. Expt. Sta., Div. Agr., U. Ark., Fayetteville, Ark.

ECONOMIC AND SOCIAL ASPECT OF SOIL AND WATER CONSERVATION

Costs and Returns

SEE ALSO 184, 187, 214, 220, 232.

235. Hendrix, A. T., and Miller, W. J. HORIZONTAL SILOS THEIR CONSTRUCTION, FILLING, USE AND CARE. Ga. Agr. Expt. Sta. B. N. S. 113, 81 pp. 1964.

Use of horizontal silos has increased rapidly during recent years. Lower initial cost, greater ease and lower cost of filling, improved effectiveness in preserving forage, and ready adaptability to self-feeding operations have increased the

desirability of horizontal silos. Recent improvements in cover materials, better methods of cover application, and lower costs for materials have contributed markedly to more effective and economic storage of forages in surface silos.

Self-feeding in horizontal silos has become more successful with increased silage quality and improved feed gate design. Fast filling with immediate covering has reduced preservation and storage losses and resulted in more palatable silage.

While not considered as substitutes or replacements for upright silos, the various types of horizontal silos offer certain advantages in first cost and in use methods that enable them to supplement the need for more forage preserving structures. In many instances, the horizontal silo may provide a needed intermediate stage in converting to a livestock production enterprise. It is expected that use of both upright and horizontal silos will continue until a more effective and economical method of preserving forage is devised.

The construction, filling, use, and care of horizontal silos were described and illustrated.

Ga. Agr. Expt. Sta., Athens, Ga.

236. Wise, J. O., and Woodworth, R. C. AN ECONOMIC ANALYSIS OF FERTILIZER AND OTHER RESOURCE USE ON FIVE BEEF CATTLE FARMS IN THE LIMESTONE VALLEY AREA OF GEORGIA. Ga. Agr. Expt. Sta. Tech. B. N. S. 37, 49 pp. 1964.

Guides for resource use on beef farms in the Limestone Valley Area of Georgia were given. Five case study farms were selected and the costs and returns associated with existing organizations and practices were examined. Optimum combinations of enterprises and levels of fertilizer on Coastal bermudagrass forage were determined for specified capital levels and feeder calf prices. The farms consisted of the following areas of openland: Farm G1 — 190 acres; Farm G2 — 200 acres; Farm W1 — 365 acres; Farm W2 — 300 acres.

Budgeting and linear programming, including the use of transfer functions, were used to determine the optimum long-run farm plans for each resource and price situation. Land, family labor and fulltime hired labor, major buildings, and machinery and equipment were considered fixed at 1961 levels.

Three investment capital situations were considered for each farm: One consisted of unlimited investment capital, the other two were determined by taking 70 and 35 percent of the current value of all assets.

Four operating capital situations were considered for each level of investment capital. One situation consisted of unlimited operating capital, the other three were determined by taking 75, 30, and 20 percent of the current value of chattel assets. The effects of changes in the price of feeder calves were analyzed for each capital situation.

The analysis on existing organizations and practices showed that an extensive land-use system of cow-calf production with little or no grain supplement resulted in a lower cost per pound of feeder calf when compared to an intensive system of production with supplement. The farm applying home produced broiler manure to forage, and using no supplement, had the lowest variable cash cost per pound of calf produced.

On the basis of the analysis of the five farms, it appears that these farms could significantly increase their incomes over current levels. Optimum farm plans for the five farms were summarized. It was assumed that there were no quantity limits on capital and that the price of feeder calves were \$0.25 per pound.

Farms with about 190 acres of openland and 2,622-3,996 hours of labor per year could achieve a net income of about \$9,900 per year with an estimated \$49,470 additional investment. The optimum plan consisted of 203 brood cows with about 60 percent of the total acreage of openland receiving an annual treatment of 200 lb. N, 50 lb. P₂O₅, and 50 lb. K₂O.

Farms with 200 acres of openland, 3,598-5,264 hours of labor per year, and broiler space for 5,300 birds annually could earn approximately \$10,430 net income with an additional investment of approximately \$63,990. In addition to 5,300 broilers annually, the optimum plan consisted of 270 beef cows with 200 lb. N, 50 lb. P₂O₅, and 50 lb. K₂O, applied annually to the 200 acres of forage.

Farms made up of approximately 117-365 acres of openland with 1,496-2,076 hours of labor annually have the potential of achieving a net income of \$3,752, with an additional investment capital about \$26,690. The optimum farm plan consisted of 107 beef cows on 79 acres of Coastal bermudagrass fertilized at the rate of 200 lb. N, 50 lb. P₂O₅, and 50 lb. K₂O per year. Oats would be produced for sale on 38 acres.

Farms with openland ranging from 545 through 600 acres and an annual labor supply of 3,711 through 5,264 hours can earn an income of about \$12,500, with an estimated \$90,372 additional investment. The optimum plan included 277 brood cows with about 100 out of 547 acres being fertilized at an annual rate of 200 lb. N, 50 lb. P₂O₅, and 50 lb. K₂O.

Farms with 300 acres of openland and 3,605-5,264 hours of labor per year can achieve an income of about \$13,600 with an additional investment of about \$72,489. The optimum plan called for 277 brood cows with 176 acres fertilized at the rate of 200 lb. N, 50 lb. P₂O₅, and 50 lb. K₂O.

Ga. Agr. Expt. Sta., Athens, Ga.

237. McArthur, W. C., Saunders, F. B., and Fortson, J. C. OPTIMUM ORGANIZATIONS FOR GENERAL CROP AND CRCP-LIVESTOCK FARMS SOUTHWEST COASTAL PLAIN AREA, GEORGIA.

Ga. Agr. Expt. Sta. B. N. S. 118, 29 pp. 1964.

The analysis indicated that substantial net returns were possible for farms in the area through adjustments in farm organization and resource use. Profitable changes in farming, however, required the use of improved production practices and above-average management.

For general crop-livestock farms, net returns to land, operator labor, and management for the optimum organizations ranged from \$1,248 for the 25-acre farm to \$36,388 for the 750-acre farm when using 1962 prices and acreage allotments. Cotton and peanuts were in the optimum organization for each size-group to the full extent of the acreage allotment.

Hogs and beef cows were in the organizations for all farmsize groups except the 25-acre farm. The importance of the livestock activities in terms of number of animals increased as the size of farm increased.

Net returns to land, operator labor, and management from optimum organizations based on projected prices and no acreage allotments ranged from \$894 for the 25-acre farm to \$33,829 for the 750-acre farm. Cotton was more important than peanuts only on the largest farm. Except for the 750-acre farm, peanuts were in all other organizations to the full extent of the agronomic restriction (one-third of cropland). Cotton utilized the remaining acreage permitted for both crops by the agronomic restrictions (the combined cotton-peanut acreage was restricted to two-thirds of total cropland).

The beef cow activity was in the optimum organizations of all farm-size groups that included this enterprise as an alternative; hogs occurred only in the optimum plans for the 25-acre farm and the two largest farms.

Net returns to land, operator labor, and management for the organizations based on 1962 prices for cotton and peanuts, projected prices for other products, and acreage allotments ranged from \$1,013 for the 25-acre farm to \$32,066 for the 750-acre farm. Cotton and peanuts were in the optimum organizations to the full extent of the acreage allotment. Beef cows were in the organizations of all farm-size groups that included this enterprise as an alternative. Hogs occurred only in the organizations of the 25-acre farm and the 400-acre farm.

Adjustments that increased income substantially required large amounts of investment capital. For the situation based on 1962 prices and acreage allotments, the requirements for investment ranged from \$6,597 on the 25-acre farm to \$167,794 on the 750-acre farm. These requirements amounted to \$264 per acre of open land on the 25-acre farm and \$244 per acre on the 750-acre farm. The investment capital requirements tended to be greater for the situation with 1962 prices for cotton and peanuts, and projected prices for other products, and acreage allotments than for the other price-allotment situations. This difference was mainly the result of more emphasis on beef cows in the organizations for the latter situation.

The analysis indicated that the investment capital needed for optimum organizations were considerably higher than the current level of capital assets for farms in the area. In particular, the organizations that emphasized livestock showed a much greater need for investment capital than the current level found on most farms in the area.

Most of the organizations based on cotton and peanut acreage allotments with 1962 prices for all commodities showed slightly higher incomes than those without cotton and peanut acreage allotments and with projected prices. The allotments restricted the acreage of cotton and peanuts and thereby released additional land and labor for livestock and grain crops.

Ga. Agr. Expt. Sta., Athens, Ga.

238. Wise, J. O. SELECTED CROP AND LIVESTOCK BUDGETS FOR NORTH GEORGIA. Ga. Agr. Expt. Sta. Mimeo. Ser. N. S. 191, 34 pp. 1964.

Differences in farm income are due to differences in the kinds and quantities of resources that are available to the farmer and to the use that he makes of these resources. Farmers can make better use of their resources by comparing the consequences of producing different products. The enterprise budgets in this report can be used by farmers in North Georgia to compare net revenues from alternative enterprises.

Farmers should also compare the results of using different levels of practices on their enterprises. Fertilizer use is one practice that is important to the net returns for different enterprises. The estimates given reflect what can be expected from applying different rates of fertilizer on forages and crops.

In general, the data presented reflect the expected results from practices usually followed in North Georgia. They do not necessarily reflect the optimum combination of practices for any given farm or year. However, the data were presented in such a manner as to permit adjustments to fit particular situations.

Tables.

Ga. Agr. Expt. Sta., Athens, Ga.

239. Martin, W. E., and Goss, W. K. COST-SIZE RELATIONSHIPS FOR SOUTHWESTERN ARIZONA CATTLE RANCHES. Ariz. Agr. Expt. Sta. Tech. B. 155, 38 pp. 1963.

Cost of beef production in Arizona's southwestern desert were examined to determine whether cost economies could be obtained by increasing herd size. Typical input structures were budgeted from cross section survey data obtained by interviews with a sample of 34 operators, supplemented by data from businessmen and others associated with the ranch industry. Costs were analyzed for nine investment sizes in three areas. Other factors receiving particular attention were range carrying capacity, variability in yearly carrying capacities, and the influence of interest on investment on total costs. The authors concluded that:

1. Considering beef production as the only ranch output, negative returns to management occurred for all sizes and types of operations when a charge was made for capital at its opportunity cost.
2. Substantial cost reductions, were obtained in the eastern desert area by expanding size to approximately 800 animal units. Beyond 800 animal units only slight cost reductions were possible. Costs decreased rapidly as rangeland carrying capacity was increased from 6 AU's per section to 20 AU's per section, with smaller decreases resulting as capacity increased to 30 AU's per section. Considering both herd size and rangeland capacity together, ranchers operating with more than 700 AU's could reduce costs more significantly by obtaining land of greater capacity than by attempting to increase herd size. Smaller ranchers could decrease costs significantly by either method.
3. In the western desert area, long-run costs of beef production decreased rapidly up to a base herd size of 300 animal units. Slight decreases occurred thereafter. Cost curves behaved in the same manner, but were at significantly lower levels, as steers were added to the base herd.
4. In general, expansion of average ranch size can be expected within Arizona's southwest desert area. Since all long-run average cost curves appear to become constant beyond a certain level of output, the primary factors limiting expansion will be the willingness of operators to assume increased investment risks together with the increased burdens which expansion places on management.

Tables and graphs.

Ariz. Agr. Expt. Sta., U. Ariz., Tucson, Ariz.

240. Kidder, R. W., Koger, M., Meade, J. H., and Crockett, J. R. SYSTEMS OF CROSS-BREEDING FOR BEEF PRODUCTION IN FLORIDA. Fla. Agr. Expt. Sta. B. 673, 19 pp. 1964.

Data from 1950-59 were presented showing pre-weaning and post-weaning performance of straightbreds and the following Brahman-British breed combinations: Firstcross, backcross, two-breed rotation cross (crisscross), and crossbred bulls mated to crossbred females (inter-se).

In the Brahman-Devon comparisons where all groups were represented, weaning weights of firstcross, backcross, and crisscross calves exceeded those of straightbreds by 17 percent (397 vs. 340 pounds). Progeny from the inter-se matings were intermediate (375 pounds, or 110 percent of straightbreds). At 18 months of age, the average weights of firstcross, backcross, and crisscross animals were 10 percent heavier (667 vs. 606 pounds) than those of straightbreds, but the inter-se progeny were similar in weight (604 pounds) to the straightbreds. Thus, crossbreds with one straightbred parent showed dramatic hybrid vigor for growth. The progeny of inter-se matings showed some advantage over straightbreds at weaning, but by 12 months of age this advantage had disappeared.

It was concluded that crisscrossing was the most practical system of cross-breeding for most ranch operations. The use of F_1 females as dams gave good results, but adequate numbers of replacement females were difficult to acquire.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.

241. Chapman, H. L., Jr., Palmer, A. Z., Kidder, R. W., Carpenter, J. W., and Haines, C. E. ORAL AND IMPLANTED STILBESTROL FOR BEEF CATTLE FATTENED ON PASTURE AND IN DRYLOT. Fla. Agr. Expt. Sta. B. 662, 16 pp. 1964.

A series of five experiments was conducted to determine the value of stilbestrol in steer-feeding programs to: (1) Compare the effect obtained on Roselawn St. Augustine-grass pasture with that in drylot; (2) determine the effect of different levels of concentrate feed intake on response to stilbestrol; and (3) compare orally administered and implanted stilbestrol in steer fattening programs. Stilbestrol significantly stimulated rate of grain except in one experiment. Oral and implanted stilbestrol each significantly increased rate of grain but had no significant effect on intransit shrink, dressing percent, cooler shrink, or slaughter grade increase, except in one experiment where variations occurred in cooler shrink. Implanted stilbestrol increased the rate of gain of steers that received no supplemental feed on pasture. When 36 milligrams were implanted, the rate of gain was further increased, with no harmful carcass effects.

When the feed nutrient supply was adequate to fatten cattle, the proper use of stilbestrol resulted in faster gains but little apparent carcass changes. The most constant benefit from stilbestrol was among steers provided a full-feed in drylot. The response to stilbestrol was more variable on pasture. However, in most cases gains were increased in pasture-fed steers. Either orally administered (10 milligrams per animal daily) or implanted (24 milligrams per animal) stilbestrol should be used in steer fattening programs. Thirty-six milligrams implanted in steers on pasture may occasionally cause a lowering of carcass grade. Therefore, no more than 24 milligrams of stilbestrol should be used for pasture-fed steers.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.

Institutional, Educational, and Social Factors Affecting Conservation Application

242. Stocker, F. D. URBAN ENCROACHMENT IN RELATION TO FARM TAXES. J. Soil and Water Conserv. 19(3): 95-97. 1964.

The level of real property taxes is a concern of the conservationist, for use of a parcel of land is often affected by the taxes on it. Rapidly increasing taxes on farmland in areas close to growing urban centers have adversely affected orderly change in land use patterns, thus creating difficulties for many land users in such areas. Considerations that all citizens might well examine as they cope with land use and economic problems inherent in the urbanization process were suggested.

ERS, USDA, Washington, D.C., 20520

243. Roseberry, J. L., and Klimstra, W. D. RECREATIONAL ACTIVITIES ON ILLINOIS STRIP-MINED LANDS. J. Soil and Water Conserv. 19(3): 107-110. 1964.

By the end of June 1962, strip mining in Illinois had resulted in the formation of 108,000 acres of spoilbanks. Between 4,000 and 5,000 acres are being added to this amount each year, and it is likely that such a rate of increase will be maintained in the foreseeable future.

To gain a broader perspective concerning problems associated with spoil from the strip mining of coal, the Cooperative Wildlife Research Laboratory of Southern Illinois University conducted a survey of all strip-mined land in Illinois. Carried out between September 1961 and June 1962, the survey was designed to reveal the amount, location, ownership, and present and potential uses of all the acreage affected by open-cut coal mining.

The current use of the more than 108,000 acres of strip-mined land in the state was shown and the recreational uses now being made of stripped areas were described.

Wildlife Res. Lab., Southern Ill. U., Carbondale, Ill.

244. Owens, G. P. INCOME POTENTIAL FROM OUTDOOR RECREATION ENTERPRISES IN RURAL AREAS IN OHIO. Ohio Agr. Expt. Sta. Res. B. 964, 51 pp. 1964.

An inventory in southern Ohio revealed the existence of some 250 outdoor recreation enterprises of types which might be established on farm lands with private capital.

Certain locational patterns were explained by geographic and demographic characteristics of the area. Vacation farms were concentrated in the eastern part of Ohio because of proximity to Eastern Cities; organized camps were concentrated in south-central Ohio because of proximity to Columbus, low land values, and very favorable terrain. Pay lakes tended to be most numerous along the Ohio River, probably because a great number of river fisherman turned to pay lakes as the river became more and more polluted.

Location was a major factor determining the size and success of recreational enterprises, and this was especially true for picnicking.

A majority of firms studied were sole proprietorships and were owner operated. Relatively few operators had any previous experience in recreation.

Over one-third of the firms borrowed money for their recreational enterprise at an average interest rate of about 5-3/4 percent.

At least one-third of all operators had plans for expansion and 82 percent of these operators indicated that they would take advantage of a low cost public loan program.

Several particular problems and limitations were common to many operators. Weather uncertainty, trespassing, trash disposal, and vandalism were significant problems to many firms.

Most operators had obtained some type of government aid in establishing their enterprises.

The profit motive was the most important factor influencing operators' decisions to provide recreational facilities.

Vacation farms were most widely advertised; brochures and newspaper articles being most important to them. Shooting preserves were the second most widely advertised type of enterprise, using newspaper, TV, outdoor signs, and direct mail. Newspaper and outdoor signs were most important to riding stables. It was found that "yellow page" advertising was an excellent media, especially near larger towns and cities.

About 80 percent of all firms carried liability insurance.

Half of the enterprises were operated in conjunction with farming. The averages of all farms were very close to the state average for commercial farms with respect to gross sales and value.

Relatively short seasons and high peaks in patronage are quite common to most types of recreational enterprises and must be planned for in advance.

Economic evaluation of the various types of enterprises provided data on labor requirements, costs of land, land improvement, buildings, operating equipment, and merchandise inventory. Averages and ranges of these capital investment costs as well as for the various expense items were analyzed along with returns in the form of fees, retail sales, etc., to give a picture of the profitability of each type of enterprise studied. Six enterprises showed a net cash loss and over half of the enterprises showed a loss after deduction of interest charges at 4-1/2 percent on invested capital. Although only three types of enterprises (pay lakes, vacation farms, and campgrounds) showed an average profit for all firms, at least one firm in each of the seven categories except riding stables made worth-while returns to family labor and management.

It was concluded that development of resources for recreation with private capital can be profitable and can provide an excellent alternative use for excess labor or land. Most operations can be started on a small scale and increased as demand warrants.

Tables.

Ohio Agr. Expt. Sta., Wooster, Ohio.

245. Krausz, N. G. P., and Lemon, L. G. LAWS AND REGULATIONS CONCERNING RECREATION IN RURAL AREAS OF ILLINOIS. Ill. Agr. Expt. Sta. C. 889, 32 pp. 1964.

As a result of the expanding population, rising living standards, and increasing amounts of leisure time in the United States, there is a need for expanded recreation facilities.

The opportunities seem especially alluring to many Illinois farmers because the state is highly urbanized and much of the land is suited for recreational development.

Information was presented on: (1) Illinois laws, court cases, and regulations that bear upon the establishment, maintenance, and operation of an income-producing farm recreation enterprise; (2) the laws on public recreation facilities in rural areas; and (3) sources of federal aid for recreation projects. State supervision, personal liability for injury, taxation, and other considerations were treated as they relate to recreation. The information is in no way intended as complete legal advice on any particular matter.

U. Ill., Col. Agr., Coop. Ext. Serv., Urbana, Ill.

BIOLOGY

Fish

SEE ALSO 4, 72.

246. John, K. R. SURVIVAL OF FISH IN INTERMITTENT STREAMS OF THE CHIRICAHUA MOUNTAINS, ARIZONA. Ecology 45(1): 112-119. 1964.

The streams of the Chiricahua Mountains, Ariz., fluctuate from standing isolated pools during the dry season to raging torrents of cloudburst origin during the rainy season. The effect these environmental extremes have on the populations of fishes was studied. The field effort was concentrated on Cave Creek and East Turkey Creek on the eastern slope of the mountains. West Turkey Creek, in the western slope, and Rucker Creek, on the southern slope, were surveyed briefly. Cave Creek and East Turkey Creek are populated by Rhinichthys osculus (Girard); West Turkey Creek by Agosia chrysogaster Girard; and Rucker Creek by Agosia chrysogaster and Campostoma ornatum Girard. The author concluded that:

1. Fish in intermittent streams of the Chiricahua Mountains, are subjected annually to environmental extremes of drought and flash floods.
2. The natural life span for most Rhinichthys osculus in the Chiricahua Mountains is less than 3 years. None was found to reach 4 years.
3. High mortality rates during summer drought must be interpreted, in part, as an acceleration of death among older fish since most fish are expected to die before they are 3 years old. Among younger fish, drought directly elevates the mortality rate.
4. Mortalities during a drought are caused directly by the disappearance of water and indirectly by starvation of fish which are crowded into reduced habitat with inadequate food.

5. Flash floods are an important cause of mortality among fish of the year if they occur while the fish are very small. The greatest potential loss of fish of the year occurs in late summer when the initial flash flood induces major reproduction and is then followed by another flash flood.
6. Flash floods are not a significant cause of mortality among older fish.
7. Temporary waters may persist in some sections through a period of wet years. The populations of fish inhibiting them are derived from upstream sections during a flash flood. All fish that were located in downstream temporary sections in the spring of 1960 were 1-year-olds.
8. Temperatures do not rise to lethal levels in any of the flowing streams. In exposed shallow isolated pools, the temperatures may become lethal for older fish, but not for fish of the year.
9. Predators play a minor role. Only one, the garter snake, Thamnophis cyrtopsis, is common and apparently important.
10. Although fish populations are greatly reduced by a year of drought, there is no immediate threat of their local extinction.

Franklin and Marshall Col., Lancaster, Pa.

247. Walker, C. R. SIMAZINE AND OTHER S-TRIAZINE COMPOUNDS AS AQUATIC HERBICIDES IN FISH HABITATS. Weeds 12(2): 134-139. 1964.

Simazine, altrazine, propazine, and prometone were tested as aquatic herbicides in fish habitats. Preemergence applications of granular formulations of simazine on attaclay or calcium sulfate of simazine at 1 to 2 p.p.m.w. controlled Potamogeton, Najas, Ceratophyllum, Heteranthera, and Zannichellia. Higher rates were required to control filamentous algae (Cladophora and Pithophora) and chara (Chara vulgaris). Early postemergence applications of wettable powder to submersed aquatics and filamentous algae were often effective. Atrazine gave similar results. Concentrations of 0.5 to 1.0 were effective in controlling Cladophora, Pithophora, and three species of Potamogeton in pond applications. Spray applications, generally, were more effective than broadcasting granular atrazine. Propazine and prometone did not control submersed species in concentrations up to 3 p.p.m.w.

Simazine had a relatively high margin of safety with respect to acute toxicity to fish. It was less toxic than propazine, prometone, or atrazine. Granular forms were less toxic than wettable powder or emulsifiable concentrates. Laboratory tests on bottom organisms gave an acute LD₅₀ toxic dosage of 28 p.p.m.w. Field observations did not demonstrate a serious reduction in the production of bottom organisms. However, the control of aquatic vegetation brought about ecological changes affecting bottom dwelling and weed clinging organisms. These changes would affect fishes with special food habits.

Bur. Sport Fisheries & Wildlife, Fish Control Lab., LaCrosse, Wis.

Upland Wildlife

248. Roseberry, J. L. SOME RESPONSES OF BOBWHITES TO SNOW COVER IN SOUTHERN ILLINOIS. J. Wildlife Mangt. 28(2): 244-249. 1964.

An unusually long period of snow coverage early in 1960 (23 consecutive days with 3-16 inches of snow) afforded an opportunity to observe responses of bobwhites (Colinus virginianus) to adverse weather conditions. Daily contact was maintained with four coveys on the 1,600-acre Carbondale Research Area in southern Illinois. Roosting and loafing sites were shifted from open to woody cover, especially clumps of Japanese honeysuckle (Lonicera japonica). As waste grain in harvested fields was

covered by snow, feeding was generally confined to small patches of unharvested corn and soybeans adjacent to woody cover. Coveys were more sedentary during the snow coverage. Daily movements varied from 70 to 600 yards, averaging 265 yards. Three late winter ranges averaging 23.7 acres were reduced during the snow to include only woody cover and unharvested cropland; one covey utilized only 3.3 acres for a period of 7 days. An estimated 29 birds perished out of a presnow population of 162; losses appeared to correlate with quality of winter range, especially the availability of agricultural grains.

Coop. Wildlife Res. Lab., Southern Ill. U., Carbondale, Ill.

249. Balser, D. S. MANAGEMENT OF PREDATOR POPULATIONS WITH ANTIFERTILITY AGENTS. J. Wildlife Mangt. 28(2): 352-358. 1964.

The search for methods other than lethal techniques, for controlling predatory animals causing economic losses to the livestock industry prompted investigation of antifertility agents to suppress reproduction. Diethylstilbestrol was selected for initial trials because of its demonstrated antifertility effect on rabbits, mink (Mustela vison), dogs, and cattle.

In penned tests with stilbestrol, pregnancy was terminated in six coyotes (Canis latrans) fed a single 100-mg. oral dose dissolved in tallow.

A subsequent field trial was conducted in New Mexico on 20 townships, March 5-15, 1963. Five thousand (100 mg. stilbestrol in 1/2 ounce of tallow) drop baits were placed wherever coyote signs were found. After a delay of 3 weeks to allow the drug to take effect, a collection of female tracts from the treated area and a reference area 25 miles away was made to measure and compare reproductive success. Of the 20 females in reproductive condition recovered from the treated area, only 4 had viable embryos, while reproduction was blocked in 16 specimens by failure of implantation or resorption of embryos. All of the 13 females in reproductive condition from the reference area would have produced pups as evidenced by viable embryos.

Future tests are scheduled to determine effects on other species and to confirm results on coyotes under a variety of field conditions.

U.S. Bur. Sport Fisheries and Wildlife, Denver Fed. Cent., Denver, Colo.

250. Harper, J. A. CALCIUM IN GRIT CONSUMED BY HEN PHEASANTS IN EAST-CENTRAL ILLINOIS. J. Wildlife Mangt. 28(2): 264-270. 1964.

The amount of calcium occurring in the grit from gizzards of 178 wild, adult pheasant hens (Phasianus colchicus) collected in east-central Illinois during the nesting cycle and during each month of the year was discussed. Grit was found in gizzards of hens collected in every month. Calcitic grit was found in the gizzards of hens in all months except December and January; calcite contained 35.6 percent calcium. Dolomitic grit was found in gizzards of hens in almost negligible quantities during April-July, only. The level of calcium in gizzard grit from wild hens was greatest during the nesting season, reaching a maximum of 3.0 percent in late May.

Among hens with known egg-laying records, the amount of calcium in the gizzard grit did not reach a level exceeding 2.0 percent until after the sixth or seventh egg had been laid. The calcium level in the grit from gizzards of hens that had laid six or seven eggs remained between 2.0 and 2.5 percent throughout egg laying and into the first few days of incubation, and then declined to near negligible amounts during the remainder of the 23-day incubation period.

Calcium in gizzard grit of hens was less than 1.0 percent during the brooding season of July and August.

Calcium in the grit from gizzards of wild hens increased from 0.1 percent in August to 2.6 percent in September and remained near this level during October and November; this increase in calcium ingestion in fall may be associated with a sexual recrudescence among both hens and cocks.

Calcium was absent from gizzard grit during December and January and was found only at levels of 0.2 percent in February and 0.1 percent in March. Wild hens demonstrated the ability not only to select calcareous grit from noncalcareous grit but also to ingest selectivity calcium-rich limestone; the grit in gizzards contained disproportionately more calcite than dolomite with respect to their ratio availability.

Ill. Natl. Hist. Survey, Urbana, Ill.

251. de Vos, A. FOOD UTILIZATION OF SNOWSHOE HARES ON MAINITOULIN ISLAND, ONTARIO. J. Forestry 62(4): 238-244. 1964.

The feeding habits of snowshoe hares (Lepus americanus) were studied on Manitoulin Island, Ontario, Canada, during 1959-62. The hares reached peak population densities in 1960 and 1961. Qualitative analyses were made by taking random cruises and quantitative data were obtained by counting available stems and evaluating their utilization on plots one chain X 6.6 feet.

The qualitative appraisal indicated heavy localized barking and girdling in winters 1958-59 and 1959-60. During winter 1960-61 barking had become more localized. No differences could be ascertained in browsing pressure during these three winters. Pinus strobus and Pinus resinosa were browsed more heavily than other conifers.

The quantitative appraisal indicated that barking pressure increased substantially from winters 1959-60 to 1960-61. Among those species most heavily barked were Populus tremuloides, Alnus rugosa, Corylus cornuta, Ostrya virginiana, Salix spp., and Populus balsamifera. No barking was observed on Rhamnus alnifolia, Fraxinus nigra, Amelanchier spp., and pine species. Browsing was locally moderate to heavy on Populus tremuloides, Betula papyrifera, Populus balsamifera, Amelanchier spp., Acer spicatum, Acer pensylvanicum, Corylus cornuta, Viburnum trilobum, Rubus idaeus, and Sambucus pubens. No browsing was observed on Rhus toxicodendron and on Rhamnus alnifolia. Larix laricina and Fraxinus nigra were only lightly browsed. Forty-four species of trees and shrubs were browsed. Snowshoe hares may affect the availability of food and plant composition by preferentially feeding on certain species resulting in a differential survival of plants utilized.

Ontario Agr. Col., Federated Colleges, Guelph, Ontario, Canada.

252. Davison, V. E. SELECTION OF FOODS BY GRAY SQUIRRELS. J. Wildlife Mangt. 28(2): 346-352. 1964.

A variety of foods was made available to unpenned gray squirrels during 1960-61 to determine, by broad preference categories, the squirrels' selection of foods from among those offered simultaneously. The principal location was on the outskirts of Athens, Ga., in woods along the Middle Oconee River.

Preferences were determined by observing through binoculars the squirrels' feeding behavior: Their ready selection, reluctant use, or refusal of the different foods. By definition, choice foods were always acceptable, whereas fair foods were eaten seldom or never as long as a choice food was available. Both choice and fair foods were recognized as important, since both were eaten in quantity and appeared to be nutritious enough to maintain life.

Tables showed the months in which each food was offered and included 69 choice foods, 9 fair, and 34 uneaten or only tasted. Protection and possibly planting of choice foods were recommended along with artificial feeding in winters following failure of mast crops.

Tables.

SCS, USDA, Athens, Ga.

253. Ward, A. L. FOODS OF THE MOURNING DOVE IN EASTERN COLORADO. J. Wildlife Mangt. 28(1): 152-157. 1964.

Crop contents of 247 mourning doves (Zenaidura macroura) taken from agricultural areas in eastern Colorado were analyzed. Grass seeds made up 29.1 percent of the total volume, with wheat (Triticum aestivum), witchgrass (Panicum spp.), corn (Zea mays), bristlegrass (Setaria spp.), sorghum (Sorghum vulgare), and ricegrass (Oryzopsis hymenoides) the most important, in that order. Forb and weed seeds made up 70.8 percent of the volume, the most important being sunflower (Helianthus spp.), doveweed (Croton texensis), pigweed (Amaranthus spp.), spiderflower (Cleome spp.), spурges (Euphorbia spp.), and violets (Viola spp.). The remaining material was of animal origin, mostly Mollusca, and made up 0.1 percent of the birds' diet. Grit was found in 61.9 percent of the crops and made up 0.4 percent of the volume. Use of the different plant seeds varied with the season.

U.S. Bur. Sport Fisheries and Wildlife, Denver, Colo.

254. Miller, R. S. ECOLOGY AND DISTRIBUTION OF POCKET GOPHERS (GEOMYIDAE) IN COLORADO. Ecology 45(2): 256-272. 1964.

The general distribution of the family Geomyidae in North America is limited only by suitable soils, although a particular species may also be limited by climatic or other factors associated with altitude and latitude and by interspecies competition. A study was made of the factors affecting the distributions of the pocket gophers Thomomys bottae, T. talpoides, Geomys bursarius, and Cratogeomys castanops in Colorado.

The most critical factors in the relationships among pocket gophers are soil tolerance and competition. All four species in Colorado prefer deep light soils, but their ranges of tolerance vary, with the result that interspecies competition consists of the fundamental niche of one species being a proper subset of another. In each combination of competitive relationships, the species with the strictest niche requirements was the superior competitor and was able to displace the other species to less favorable habitats. The relationship among the four species in competitive ability was G. bursarius > C. castanops > T. bottae > T. talpoides.

Possible mechanisms of competition were discussed in relation to body size, territory, aggression, and dispersal.

U. Saskatchewan, Saskatoon, Canada.

255. Anderson, W. L. SURVIVAL AND REPRODUCTION OF PHEASANTS RELEASED IN SOUTHERN ILLINOIS. J. Wildlife Mangt. 28(2): 254-264. 1964.

Nine hundred game-farm pheasants (Phasianus colchicus), from California stock, and 814 wild-trapped pheasants, from east-central Illinois, were released during the winters of 1959-60 and 1960-61, on an area near Neoga, located about 20 miles south of the range occupied by self-maintaining populations in Illinois.

Initial efforts to test the ability of crosses among different species, subspecies, and strains of pheasants of the genus Phasianus to produce self-maintaining populations south of the contiguous range now occupied by pheasants in Illinois were made.

Wild Illinois pheasants, survived in significantly greater numbers than California birds. Survival of the sex and age groups of each strain was similar. Reproductive success of the wild Illinois birds and of their progeny, in 1960 and 1961, was similar to that of pheasants in self-maintaining populations; California birds, for the most part, failed to reproduce. The rate of death among adult hens during the late summer was probably higher at Neoga than within the established pheasant range.

Survival of pheasant hens from October to the following May averaged 28 percent for the 2 years, 1960-61 and 1961-62, and was apparently insufficient to allow establishment and continuation of the population. Factors preventing the southward extension of self-maintaining pheasant populations in Illinois were concerned more with survival than with reproduction.

Ill. Natl. Hist. Survey, Urbana, Ill.

256. Johnson, D. R. EFFECTS OF RANGE TREATMENT WITH 2,4-D ON FOOD HABITS OF RODENTS. *Ecology* 45(2): 249-256. 1964.

The food habits of rodents inhabiting shrub grass and perennial forb ranges in western Colorado were investigated to determine the kinds and proportions of food eaten, the effects of range treatment with 2,4-D on food habits, and the degree of competition for food among rodents inhabiting these ranges. Treated and control areas at each site were trapped periodically and estimates were made of plant coverage. A part of the stomach contents of each rodent was mounted on a slide and was examined under the microscope. The volume in percent of each food item was estimated and recorded.

Deer mice exhibited a seasonal variation in diet. Their winter food was primarily seeds whereas arthropods made up a large part of the diet during the summer months. Cutworms comprised almost one-half of the food ingested during June. Male and female deer mice showed no difference in diet, but the diet of deer mice varied with age group. Fungi were found in the stomachs of rodents, particularly during the fall months. Deer mice occasionally ingested parts of small mammals. Grass seeds comprised a larger proportion and forb and shrub seeds a smaller proportion of the diet of deer mice inhabiting areas treated with 2,4-D than that for untreated areas. The availability of food items appeared to be responsible for these observed differences.

Least chipmunks ate a variety of arthropods, seeds, and leaves, and, like the deer mouse, exhibited seasonal variation in diet. Although there was no significant difference in diets on treated and control area, the influence of the availability of certain seeds was evident.

Range treatment with 2,4-D had no effect on the diet of montane voles. Leaves and stems of forbs and shrubs comprised a large part of the summer diet on both treated and control areas of Grand Mesa. Differences in diet and sex and age were observed. The greater abundance of montane voles on treated areas appeared to be due to an increase in grass cover and not to an increase in available food.

No competition for food was observed among deer mice, least chipmunks, and montane voles at the population levels sampled.

Colo. State U., Agr. Expt. Sta., Fort Collins, Colo.

257. Ferguson, D. E. SOME ECOLOGICAL EFFECTS OF HEPTACHLOR ON BIRDS. J. Wildlife Mangt. 28(1): 158-163. 1964.

A 2-year study was devoted to determining effects on birds of heptachlor applications in varying amounts (0.25, 0.50, and 2.00 lb./A.), used in attempts to eradicate the imported fire ant (Solenopsis saevissima) in Mississippi. All treatment rates decimated arthropod populations, caused bird mortality, and altered bird behavior patterns; none eradicated the ants permanently. More birds died after an application of 0.25 lb./A. than after applications of 0.50 and 2.00 lb. Nesting birds and ground-dwelling insectivorous birds were most noticeably affected, presumably through contamination of insect food sources.

Recovery of insect and bird populations from the effects of treatment was fairly complete after the lapse of a year. Measures suggested for reducing wildlife damage included: Restricting treatment to relatively small acreages; applying insecticides outside the nesting season; and using such alternative methods of attack on fire ants as baits, individual mound treatment, and more selective insecticides.

Miss. State U., State College, Miss.

258. Johnson, F. M., Stubbs, J., and Klawitter, R. A. RODENT REPELLENT VALUE OF ARASAN-ENDRIN MIXTURES APPLIED TO ACORNS. J. Wildlife Mangt. 28(1): 15-19. 1964.

A mixture of Arasan 75 and Endrin 50W was tried in two concentrations on acorns of Shumard oak (Quercus shumardii) and swamp chestnut oak (Q. michauxii) to determine its effectiveness in protecting acorns from damage by gray squirrels (Sciurus carolinensis) and cotton rats (Sigmodon hispidus). Treated and untreated acorns were exposed to 12 gray squirrels and cotton rats in a series of cage tests.

The repellent was effective against both squirrels and cotton rats when untreated acorns were also available. It was quite effective against cotton rats, but not against squirrels, when only treated acorns were available. In periods of abundant alternate food supplies, a direct seeding of treated acorns should produce a good stand, but this may not be true under adverse food conditions.

U.S. Fish and Wildlife Serv., Asheville, N.C.

Wetland Wildlife

SEE ALSO 4.

259. Vogl, R. J. THE EFFECTS OF FIRE ON A MUSKEG IN NORTHERN WISCONSIN. J. Wildlife Mangt. 28(2): 317-329. 1964.

The effects of prescribed burning on the vegetation of Powell-Flambeau Marsh were studied during summers of the years 1959-62. This area, located in north-central Wisconsin, is a hybrid community of open sphagnum bog or treeless muskeg and sedge meadows. The marsh is being managed to increase its productivity for wildlife, particularly for geese, ducks, sharp-tailed grouse (Pedioecetes phasianellus), and white-tailed deer (Odocoileus virginianus). The burning was analyzed quantitatively using 14 paired stands, one member of each pair being an unburned control adjacent to the burned area. The vegetation within each stand was sampled using quadrat frequency studies. To evaluate the effects of fire, all plant species were divided into groups called increasers, decreasers, neutrals, invaders, or retreaters, depending upon their responses to fire as reflected in average percent frequency changes.

Prescribed burning produced a conversion or retrogression from conifer swamp dominated by trees to open sphagnum bog or muskeg dominated by sedges and ericaceous shrubs. The muskeg may be changed further to northern sedge meadows, dominated by sedges and supporting a minimum of woody vegetation. This sedge meadows successional stage was considered more desirable than the other types because it allows the greatest movement, feeding, and nesting of game birds. Fire also improved game habitat by reducing the "rough" of woody and nonwoody plants, stimulated new and palatable growth, and increased fruit and seed production.

Los Angeles State Col., Los Angeles, Calif.

260. Merz, R. W., and Brakhage, G. K. THE MANAGEMENT OF PIN OAK IN A DUCK SHOOTING AREA. J. Wildlife Mangt. 28(2): 233-239. 1964.

Study plots in normal and artificially flooded pin oak (Quercus palustris) stands at the Duck Creek Wildlife Management Area in southeastern Missouri indicated that good pin oak acorn crops were probably cyclic and that dormant season flooding apparently did not affect acorn production. Clearing all but the desired acorn-producing trees and seeding Japanese millet (Echinochloa crusgalli var. frumentacea) in the clearings was a satisfactory means of supplementing pin oak mast as food in a duck shooting area.

Duck kill per hunter during 2 comparable years averaged higher in blinds where both pin oak mast and millet were available.

Central States Forest Expt. Sta., FS, USDA, Columbus, Ohio.

261. Rogers, J. P. EFFECT OF DROUGHT ON REPRODUCTION OF THE LESSER SCAUP. J. Wildlife Mangt. 28(2): 213-222. 1964.

Responses of the lesser scaup (Aythya affinis) to severe drought were studied on a 1-square-mile pothole area in southwestern Manitoba from 1957-60. The population decreased 63 percent in 1959 and 29 percent in 1960. The decline resulted from an abrupt decrease in water level. This caused an abnormally early departure of pairs from their nesting potholes, which were either dry or had wide mud flats exposed around the perimeters early in the season.

Another important factor in the decline was a failure in production. In 1959, when habitat conditions were poorest, nesting was inhibited in most of the resident pairs. Groups of pairs loafed on the larger potholes throughout the season. Inhibition was reflected in low ovarian weights and follicular atresia. The presence of mud flats, rather than lack of nesting cover around the pothole perimeters, appeared to be the inhibitory factor. In 1958 and 1960, strong nesting efforts were made but were broken up by excessive predation, mostly by skunks (Mephitis mephitis).

Scaups appear to be more vulnerable than other ducks to nest predators because they nest late in the season when predators are more abundant, and they nest close to the edge of the water where predators frequently hunt. The effect of nest predation on scaup production is especially severe because few hens renest if the first nest is lost.

Gaylord Memorial Lab., U. Mo., Puxico, Mo.

262. Vaught, R. W. RESULTS OF TRANSPLANTING FLIGHTLESS YOUNG BLUE-WINGED TEAL.
J. Wildlife Mangt. 28(2): 208-212. 1964.

During a 3-year period, 377 local (flightless young) and 14 adult blue-winged teal (Querquedula discors) were transferred from Minnesota to Missouri in an effort to reestablish nesting populations. All releases were banded and color-marked at release sites. Direct recoveries following release indicated that northward migration occurred after the blue-wings were capable of flight; some recoveries suggested migrational homing. Types of homing, as described by Griffin (1952), probably were involved in flights from release sites to recovery areas. No color-marked ducks were recorded at release sites in spring, indicating that this attempt to reestablish nesting blue-winged teal by the release of flightless ducklings without parents was unsuccessful.

Mo. Conserv. Comn., Columbia, Mo.

263. Weller, M. W. DISTRIBUTION AND MIGRATION OF THE REDHEAD. J. Wildlife Mangt. 28(1): 64-103. 1964.

An analysis of the distribution and migration of the redhead (Aythya americana) was based on aerial survey and band recovery data accumulated by the U.S. Fish and Wildlife Service. Additional data from States outside routine survey areas were obtained from state waterfowl biologists and from published data.

The redhead is prevalent in the Prairie Pothole Region, predominantly in the South and West. The redhead has recently expanded to marginal range in Alaska and in several Southern States, probably as a result of the serious drought of 1958-61. Approximately 78 percent of all redheads winter on the east coast of Texas in the highly saline Laguna Madre. About 14 percent use the East Coast (Chesapeake Bay to Florida), less than 3 percent the West Coast. Small numbers of birds will winter wherever winter remains free of ice.

Fall migration starts in mid-September and reaches its peak in mid-October. Most birds are on the wintering areas in late November and December. Birds from the south and west parts of the Prairie Region move due south to Texas; birds reared in the east and north sections tend to move to the East Coast. Most birds from the Great Basin Area move due south or southeastward to winter in Texas; relatively few migrate to the East Coast. Movements are sufficiently distinct that breeding populations can be distinguished on the basis of the proportion of birds moving to each of the three major wintering areas.

Banding of adults on wintering areas indicated that a small percentage of birds shift from one wintering area to another. Late summer northward and eastward movements are common among juveniles and adults. The present distribution and migration pattern indicates that the redhead originated in Western or Southwestern North America. It was suggested that the redhead has only recently invaded the Prairie Pothole Region, either because of loss of habitat in its area of origin or because of the expansion of a successful species.

Iowa State U., Ames, Iowa.

264. Oring, L. W. BEHAVIOR AND ECOLOGY OF CERTAIN DUCKS DURING THE POST-BREEDING PERIOD. J. Wildlife Mangt. 28(2): 223-233. 1964.

Behavior and ecology of 13 species of ducks were studied from June 5 to August 29, 1961, at Camas National Wildlife Refuge in southeastern Idaho. Drakes were observed from the time they left their broods until they regained flight.

Males of most species left their mates at the onset of, or early in, the incubation period and formed large aggregations, which persisted throughout the flightless period. Mallards (Anas platyrhynchos) were first to form such groups, followed in the order named by pintails (Anas acuta), other dabbling ducks, and diving ducks. These preflightless flocks fed most actively in early morning, than bathed and played. The birds spent most of the daylight hours preening, sleeping, or resting along the shore. Concentrations of dabbling ducks were present in all marshes larger than a few acres. Diving ducks and American widgeons (Mareca americana) gathered on large lakes and remained in open water. Most females remained in or near their brood-rearing areas during wing-molt; a few joined the males.

U. Okla., Norman, Okla.

SUPPLEMENT

Problems Indirectly Affecting the Application of Soil and Water Conservation Practices

SEE ALSO 257.

265. Colorado Extension Service. INSECT CONTROL GUIDE FOR COLORADO: CEREAL CROPS; FIELD CROPS; FORAGE CROPS; STORED GRAIN. Colo. Ext. Serv. Gen. Ser. 800, 19 pp. 1964.
266. Colorado Extension Service. INSECT CONTROL GUIDE FOR COLORADO: VEGETABLE CROPS. Colo. Ext. Serv. Gen. Ser. 802, 22 pp. 1964.

These two publications presents the 1964 recommendations for insect control in Colorado for the crops listed.

Tables.

Ext. Serv., Colo. State U., Fort Collins, Colo.

267. Wells, H. D. GEORGIA TURFGRASS DISEASES AND THEIR CONTROL. Ga. Agr. Expt. Sta. C. N. S. 39, 16 pp. 1963.

Southern home owners, greenskeepers, sportsmen, and engineers are demanding high-quality turf that will stabilize the soil, withstand play and traffic, and beautify the premises. Research and practical experience have demonstrated that centipede, zoysia, St. Augustine, and bermudagrasses are the perennial species best suited for turf in the South. Although there are serious defects in carpet and bahiagrasses, considerable turf of these species has been established. Annual ryegrass is the most dependable grass for winter turf. All of these grasses are subject to diseases which reduce their utility. Much of this damage may be reduced or minimized if home owners and turf workers can become acquainted with the symptoms of and control measures for the more destructive diseases of various grasses.

The more troublesome diseases were discussed and a key to be used in their identification was given. A list of the best chemical treatments or practices for their control was included.

Ga. Agr. Expt. Sta., Athens, Ga.

268. Dubey, H. D., and Freeman, J. F. INFLUENCE OF SOIL PROPERTIES AND MICROBIAL ACTIVITY ON THE PHYTOTOXICITY OF LINURON AND DIPHENAMID. *Soil Sci.* 97(5): 334-340. May 1964.

The herbicides linuron and diphenamid are being recommended by their manufacturers for preemergence weed control in field crops.

Initial phytotoxicity of linuron and diphenamid in 11 soil types from Kentucky was studied under greenhouse conditions. Attempts were made to relate the toxicity to: Percent of sand, silt, clay, and organic matter content; cation-exchange capacity; exchangeable bases; soluble phosphorus; pH; and microbial activity in soils.

The majority of the soils required from one and a half to two times as much linuron as diphenamid to cause a 50 percent growth reduction of the test plant.

ED_{50} (amount of chemical which reduces the green weight of the shoot by 50 percent) values of the herbicides were not correlated with clay content in the soil.

Simple positive correlations were noted between linuron ED_{50} values and organic matter content, cation-exchange capacity, and exchangeable magnesium and potassium. Diphenamid ED_{50} showed positive simple correlations with organic matter content, cation-exchange capacity, and exchangeable magnesium. Of these soil factors, organic matter showed the highest correlation with ED_{50} values.

In sterilized soils, linuron was three times and diphenamid two times more toxic, indicating the microbial nature of decomposition of these herbicides.

Berea Col., Box 669, Berea, Ky.

269. Juska, F. V., and Hanson, A. A. EFFECT OF PREEMERGENCE CRABGRASS HERBICIDES ON SEEDLING EMERGENCE OF TURFGRASS SPECIES. *Weeds* 12(2): 97-101. 1964.

Preemergence herbicides for the control of crabgrass (Digitaria ischaemum (Schreb.) Muhl. and D. sanguinalis (L.) Scop.) were applied on bluegrass sod at three different rates for 3 years to determine residual effects on the stand and vigor of perennial ryegrass, red fescue, tall fescue, and Merion bluegrass, and common Kentucky bluegrass seedlings. With few exceptions, the herbicides retarded stand and vigor of these turfgrasses seeded in turf killed with methyl bromide. Chlordane was least and a commercial arsenic complex plus 7 percent N most toxic to young seedlings. Seedlings of Merion Kentucky bluegrass were most resistant to herbicide injury. No appreciable decrease in original turf density was noted except for the arsenic complex material which severely injured bluegrass turf at the two heavier rates.

Germination of the same turfgrasses seeded in flats of sterilized soil in the greenhouse 1 day, 41 days, and 93 days after the application of preemergence crabgrass herbicides, showed the most reduction in emergence from treatments with DMPA [0-(2,4-dichlorophenyl) O-methyl isopropylphosphoramidoate], trifluralin (2,6-dinitro-N,N-di-n-propyl-alpha-alpha-trifluoro-p-toluidine), DCPA (2,3,5,6-tetrachloro-terephthalic acid), and dipropalin (N,N-di-n-propyl-2,6-dinitro-p-toluidine). Lead arsenate was least injurious to germinating seedlings. Tall and red fescue were more tolerant to herbicides than the other grasses studied.

CRD, ARS, USDA, Beltsville, Md.

270. Harris, C. I., and Warren, G. F. ADSORPTION AND DESORPTION OF HERBICIDES BY SOIL. *Weeds* 12(2): 120-125. 1964.

The adsorption of herbicides from aqueous solution by muck, bentonite, an anion exchanger, and a cation exchanger was studied. The nature of the absorbant, pH, and temperature all influenced adsorption, and different herbicides responded differently to changes in these factors. Lowering of the pH resulted in increased adsorption by bentonite of all of the herbicides studied, except diquat which was completely adsorb-

ed at both a high and a low pH. The influence of pH was greatest for DNBP and atrazine. The DNBP was adsorbed by an anion exchanger, but not by a cation exchanger, while CIPC, monuron, and atrazine were adsorbed by both. Diquat was completely adsorbed by the cation exchanger and only slightly by the anion exchanger. All were adsorbed by muck but to varying extents as follows: diquat > CIPC > DNBP > monuron > atrazine. No relationship was found between water solubility at 0° C. than at 50° C., but adsorption by muck was the same at both temperatures.

Desorption studies were conducted using C-14 labeled atrazine, monuron, simazine, and 2,4-D. Repeated extractions with distilled water desorbed these herbicides from bentonite and muck and their desorption was more readily accomplished from bentonite than from muck.

CRD, ARS, USDA, Beltsville, Md.

271. Shaw, M. D., and Patel, N. G. PASTEURIZING WATER WITH DOMESTIC WATER HEATERS. Agr. Engin. 45(4): 200-201. \$0.50. 1964.

A pasteurizing system was described that was developed to hold water for a minimum of 30 minutes at 145° F. A heat exchanger preheats the incoming water and cools the effluent when hot water is not needed.

For sale by ASAFA, 420 Main St., St. Joseph, Mich., 49085

272. Yung, F. D. FARMSTEAD WATER DEMANDS AND PEAK USE RATES. Trans. ASAE 7(2): 179. 1964.

Quantitative data on water demands and peak-use rates are essential to good design of farm water-distribution systems.

Demands and peak-use rates for various outlet fixtures were obtained from records on eight Nebraska farms and in a Lincoln city home for periods ranging from 1 to 2 years. The records were made by means of recording flowmeters.

DEMANDS OF SINGLE FIXTURES
(AS FOUND)

Fixture	Number of fixtures tabulated	Average demand (gpm)	Peak use (gpm)
Kitchen sink	9	2.8	4.8
Lavatory	12	2.6	5.5
Toilet	12	3.1	4.8
Tub	9	3.2	5.7
Shower	8	2.6	5.0
Automatic washer	7	3.6	4.6
Washer	2	2.3	3.3
Hydrant	10	5.2	13.0
Sill cock	3	3.8	5.0
Sprinkler	3	3.2	7.0
Automatic livestock waterer	4	1.7	3.1
Irrigation (garden and flowers)	2	3.7	6.2
Air conditioner (water cooled)	1	1.8	1.9

U. Nebr., Lincoln, Nebr.

273. Hendrickson, R., and Kesterson, J. W. CITRUS MOLASSES. Fla. Agr. Expt. Sta. Tech. B. 677, 27 pp. 1964.

Processing techniques and analyses of citrus molasses were studied and compared, as were intermediary, laboratory, and related products. The one factor that would contribute most toward making an improved molasses was found to be clarification of citrus press liquor prior to concentrating. The advantages were: A physically more attractive product; lower viscosity; higher sugar content; lower ash content; a higher possible concentration; and improved storage stability.

Scale on heat exchange surfaces was established to be mostly calcium citrate, and methods were described for both avoiding its build-up and cleaning the heat exchange surfaces. Froth fermentation or foaming of citrus molasses, which has only rarely occurred in recent years, was investigated, and procedures were described for decreasing the possibility of occurrence and controlling the condition when it happened. Citrus molasses decreased slightly in sugar content and increased in viscosity when stored for an extended period of time. The viscosity was decreased greatly by agitation.

A review of uses for citrus molasses showed it to be palatable to all classes of beef cattle. It has been used to replace ground snapped corn in fattening rations with excellent results. Citrus molasses was also useful in the recovery of citrus bioflavonoids and the manufacture of: Brandy neutral spirits; feed yeast; lactic acid; bland syrup; citrus vinegar; methane; 2,3-butylene; glycól; riboflavin; and citric acid.

U. Fla., Agr. Expt. Sta., Gainesville, Fla.

Radioactive Fallout

274. Haghiri, F., and Johnson, R. R., Eds. PROCEEDINGS OF THE NORTH CENTRAL EXPERIMENT STATIONS WORKSHOP ON RADIONUCLIDES IN FOODS AND AGRICULTURAL PRODUCTS, February 19-21, 1963, Cincinnati, Ohio. Ohio Agr. Expt. Sta. Sp. Rpt. Ser. 1. 1963.

The proceedings of the North Central Experiment Stations workshop on radionuclides in foods and agriculture products were presented. The following gives the name, title of paper, and the address of the author for each paper presented.

275. Krauss, W. E. INTRODUCTORY REMARKS. Ohio Agr. Expt. Sta., Wooster, Ohio.

276. Kottman, R. M. INTRODUCTION AND GOALS OF WORKSHOP. Ohio Agr. Expt. Sta. Wooster, Ohio.

277. Klement, A. W., Jr. SOURCES OF RADIOACTIVITY IN FOODS. U.S. Atomic Energy, Comn. Washington, D.C., 20005.

278. Comar, C. L., and Thompson, J. C., Jr. BEHAVIOR OR FALLOUT RADIOCONTAMINANTS IN THE FOOD CHAIN. Cornell University, Ithaca, N.Y.

279. Todd, F. A. RADIONUCLIDES IN FOODS AND AGRICULTURAL PRODUCTS MILK PRODUCTION AND DAIRY PRODUCTS PROCESSING. ARS, USDA; Washington, D.C., 20005.

280. Patrick, H. RADIOACTIVITY IN FOODS-POULTRY AND ANIMALS IN GENERAL. W. Va. U., Morgantown, W. Va.

281. Rivera, J. STRONTIUM 90 IN U.S. WHEAT AND FLOUR. U.S. Atomic Energy Comm., Washington, D.C., 20005

282. Gustafson, P. F. RADIOACTIVITY IN GRAINS. Argonne Nat. Lab., Argonne, Ill.

283. Laug, E. P. SURVEY OF RADIOACTIVITY IN FRUITS AND VEGETABLES. Food and Drug Admnn., Dept. Health, Ed. and Welfare, Washington, D.C., 20005

284. Klement, A. W., Jr. CURRENT RESEARCH ON RADIOACTIVE CONTAMINATION OF SOILS AND PLANTS. U.S. Atomic Energy Comm., Washington, D.C., 20005

285. Chadwick, D. R., and Straub, C. P. GUIDELINES FOR TOLERANCE LEVELS OF RADIONUCLIDES IN MAN. Div. Radiological Health, U.S. Public Health Serv., Washington, D.C., 20005

286. Campbell, J. E. INDUSTRIAL PROCESSES FOR THE REMOVAL OF RADIONUCLIDES FROM MILK. U.S. Public Health Serv., Robt. A. Taft Sanitary Engin. Cent., Cincinnati, Ohio.

287. Branson, B., Burmann, F., and Kahn, B. METHODOLOGY AND INSTRUMENTATION FOR MEASURING RADIONUCLIDES IN FOODS. U.S. Public Health Serv., Robt. A. Taft Sanitary Engineering Cent., Cincinnati, Ohio.

288. Straub, C. P., and Fooks, J. H. EFFECTS OF FARM PRACTICES ON RADINUCLIDES IN MILK. Radiological Health Res. Act., Robt. A. Taft Sanitary Engin. Cent., Cincinnati, Ohio.

289. Harper, W. J. REPORT OF MILK PRODUCTION AND DAIRY PRODUCTS PROCESSING GROUP. Ohio Agr. Expt. Sta., Wooster, Ohio.

290. Kastelic, J. SUMMARY OF A DISCUSSION ON RADIONUCLIDES IN MEATS, EGGS AND FARM ANIMALS. U. of Ill., Urbana, Ill.

291. Gilles, K. A. REPORT OF CEREALS AND FORAGE CROPS GROUP. N. Dak. State U., Fargo, N. Dak.

292. Bukovac, M. J. AN EVALUATION OF THE NEED FOR RESEARCH AND THE ROLE OF THE AGRICULTURAL EXPERIMENT STATION IN STUDIES CONCERNING RADIONUCLIDES IN FRUITS AND VEGETABLES. Mich. State U., East Lansing, Mich.

293. Mortensen, J. L. REPORT OF SOILS AND WATER GROUP. Ohio Agr. Expt Sta., Wooster, Ohio.

294. Norman, A. G. SUMMARIZATION. Plant Nutr. Lab., Radiation Lab., U. Mich., Ann Arbor, Mich.

295. Wiklander, L. UPTAKE, ADSORPTION AND LEACHING OF RADIOSTRONTIUM IN A LYSIMETER EXPERIMENT. Soil Sci. 97(3): 168-172. Mar. 1964.

The lysimeter experiment was started in 1957 with an acid soil (pH = 4.5). By liming and potassium fertilization, four different treatments were arranged. In 1958 50 μ C. Sr90, as SrCl₂, was added to the surface soil with the object of studying: (1) The translocation of Sr into the underlying soil; (2) the distribution between exchangeable and nonexchangeable forms; (3) the loss of Sr by leaching; and (4) the uptake of Sr by crops during 1959-62, all as affected by liming and potassium fertilization. The author concluded that:

1. Liming retarded the translocation of Sr from the surface soil to the sub-soil in accordance with the theory. In the unlimed soils, 32 percent of the Sr was found below a depth of 15 cm. and in the limed soils only 11.0 percent. Potassium fertilization somewhat increased the downward movement of Sr.
2. Of the Sr retained by the soil 10 to 12 percent was transferred into non-exchangeable form.
3. The loss of Sr by leaching during 1958-62 was very small (about 1.2 percent of added Sr) and showed no significant influence of liming, which was due to the same composition of subsoil.
4. Liming strongly reduced the uptake of Sr by plants (40 to 45 percent).
5. Four successive crops together took up 4.5 to 9.2 percent of added Sr. Red clover took up around 7 to 9 times as much as wheat and barley; in one red clover crop on unlimed soil not less than 5.0 percent of the added Sr was absorbed.
6. Of the Sr taken up by barley, 3.9 percent was found in the seed and 96.1 percent in the straw.

Potassium fertilization decreased the Sr uptake by red clover but not that by barley and not significantly that by wheat.

The data from the lysimeter experiments showed that the liming of acid soils contaminated with radioactive Sr had a beneficial effect on the crops by decreasing Sr availability, for it thus reduced its uptake and, consequently, the hazards of radiation. Liming may also have an unfavorable effect, in that it decreased Sr translocation in the soil, thus preserving Sr in the topsoil or in the limed horizon and decreased its loss by leaching.

Agr. Col., Sweden, Uppsala 7, Sweden.

296. Place, G. A., and Barber, S. A. THE EFFECT OF SOIL MOISTURE AND RUBIDIUM CONCENTRATION ON DIFFUSION AND UPTAKE OF RUBIDIUM-86. Soil Sci. Soc. Amer. Proc. 28(2): 239-243. 1964.

An autoradiographic technique was used to study the effect of soil moisture and Rb concentration on Rb-86 diffusion and uptake by corn plants. Changes in soil moisture influenced the rate of diffusion, rate of root elongation, and the incidence of root hairs. The self-diffusion of Rb-86 was linearly correlated ($R^2 = 0.89$) positively with soil moisture, Rb concentration, and interaction of these two factors.

The correlation of Rb-86 uptake from the soil was positively correlated with Rb-86 diffusion values approximated from measurements made of the depleted areas about the roots. When the root diameter used in the calculation included the length of the root hairs, the r^2 was 0.70 and when the root hairs were not included the r^2 was 0.56. The correlation of uptake with the values of Dp/b from selfdiffusion studies gave an r^2 of 0.99.

Uptake by roots without root hairs was linearly correlated ($r^2 = 0.98$) with soil moisture, Rb concentration, and their interaction. Since the uptake relationships were similar whether or not the roots possessed root hairs, it was concluded that moisture's effect on rate of diffusion was of greater significance in its effect on Rb-86 uptake than was its effect on root hair incidence.

U. Ark., Fayetteville, Ark.

297. Smith, L. H., Rasmusson, D. C., and Myers, W. M. INFLUENCE OF GENOTYPE UPON RELATIONSHIP OF STRONTIUM-89 TO CALCIUM IN GRAIN OF BARLEY AND WHEAT. *Crop Sci.* 3(5): 386-389. 1963.

In barley, statistically significant differences in Sr-89 and Ca contents and ratio of Sr-89/Ca were observed among 20 varieties. These differences were relatively reproducible between two experiments conducted under different environmental conditions. Significant varietal differences with respect to Sr-89 and Ca contents, and Sr-89/Ca ratio and the consistency of the differences under different environmental conditions suggest genetic control of these factors.

A regression analysis indicated a general positive relationship between Sr-89 and Ca accumulation in the grain. However, varietal exceptions to this general relationship were also significant. Discrimination against Sr-89 accumulations by some varieties was suggested by varieties containing relatively high levels of Ca and low levels of Sr-89.

In wheat, significant varietal differences were observed for Sr-89 and Ca contents and Sr-89/Ca ratio. The data for Sr-89 accumulation were reproducible over the two experiments, whereas the data for Ca were not. The relationship of Sr-89 to Ca, as indicated by Sr-89/Ca ratios was relatively consistent over the two experiments. These data suggest a major influence of plant genotype upon Sr-89 accumulation and ratio of Sr-89/Ca in the grain of some wheat varieties.

The grain of the two species tested, barley and wheat, showed essentially the same accumulation of Sr-89 and Ca, indicating that little differences existed between these two species for Sr-89 and Ca accumulation.

U. Minn., St. Paul, Minn.

298. Sparks, W. C., and Iritani, W. M. THE EFFECT OF GAMMA RAYS FROM FISSION PRODUCT WASTES ON STORAGE LOSSES OF RUSSET BURBANK POTATOES. *Idaho Agr. Expt. Sta. Res. B.* 60, 27 pp. 1964.

Gamma rays from fission product wastes inhibited the sprouting of Russet Burbank Potato tubers. The best dosage seemed to be 10 kiloreps with very little difference between this dosage and the 5 kilorep or the 20 kilorep treatments. These 3 treatments did differ considerably from the 40 and 80 kilorep treatments. The higher dosages had almost twice as much loss as did the three lower dosages.

The tubers should not be irradiated immediately after harvest. Irradiation any time after the tubers had been harvested and stored for 70 days showed higher desirable results.

Tubers irradiated at the optimum range (around 10 kiloreps) were kept as long as 502 days without sprouting, and were quite firm and salable 300 days after treatment. The higher the storage temperature, the greater the weight loss.

U. Idaho, Col. Agr., Idaho Agr. Expt. Sta., Moscow, Idaho.

AUTHOR INDEX
(Figures refer to index number)

Adams, J. E., 52
Adams, M. V., 185
Adams, R. S., Jr., 85
Adams, W. E., 102
Agarwala, S. C., 174
Akesson, N. B., 168
Alban, K., 4
Allen, E. J., 214
Allen, R. M., 203
Allen, W. S., 127
Allred, W. M., 126
Anderson, L. E., 141
Anderson, W. L., 255
Augustine, M. T., 149

Bailey, L. W., 111
Balser, D. S., 249
Barber, S. A., 63, 296
Barker, D. S., 113
Bartee, L. D., 184
Barton, L. W., 25
Bassett, J. R., 204
Bearfoot, A. D., 24
Beasley, R. P., 24
Beattie, J. M., 7
Beavers, A. H., 116
Becker, W. B., 206
Beckett, P., 65
Benz, L. C., 169, 172
Bernstein, L., 96
Berry, C. R., 181
Betson, R. P., 11
Bhan, V. M., 144
Bhide, V. K., 64
Bidwell, O. W., 119
Bierwagen, G. G., 131
Bingham, F. T., 59
Binnie, R. R., 63
Bitoun, M., 41
Black, W. R., 66
Blackmarr, W. H., 8
Blake, G. R., 51
Boawn, L. C., 89
Boelter, D. H., 10, 51
Boggess, W. R., 111
Bond, J. J., 13
Bonnet, J. A., 145
Bowen, H. J. M., 82
Bradford, G. R., 94
Brady, N. C., 107, 180
Brakhage, G. K., 260
Branson, B., 287

Brewer, R., 112
Brogan, J. C., 74
Brol, S. W., 115
Brooks, O. L., 218
Brown, A. L., 71
Brown, M. E., 86
Brubacher, R. H., 60
Buck, P., 197
Burke, W., 30
Burlingham, S. K., 86
Burmann, F., 287
Burns, R. M., 213
Burnside, O. C., 229
Burton, J. D., 200
Bukovac, M. J., 292

Campbell, J. E., 286
Campbell, R. W., 141
Carpenter, J. W., 241
Cary, J. W., 44
Case, V. W., 107
Cawse, P. A., 82
Chadwick, D. R., 285
Chao, T., 76
Chaplin, J. F., 142, 220, 232
Chapman, H. L., Jr., 95, 190, 191, 241
Chesters, G., 55
Chipman, E. W., 106
Clyma, W., 20
Coggins, C. W., Jr., 213
Coleman, N. T., 57, 68
Colorado Extension Service
 265, 266
Colville, W. L., 229
Comar, C. L., 278
Cook, E. D., 175
Cook, W. P., 146
Cornelius, D. R., 91
Coulter, B. S., 74
Cowett, E. R., 185
Cox, F. R., 98
Crockett, J. J., 193
Crockett, J. R., 240
Culp, T. W., 224
Cummins, D. G., 83
Cunha, T. J., 190
Currin, R. E., 220

Danner, M. J., 215
Davis, R. J., Jr., 43
Davison, V. E., 252
DeMumbrum, L. E., 55
de Vos, A., 251
Doering, E. J., 171
Dortignac, E. J., 134
Douglas, A. G., 218
Dubey, H. D., 268
Dumm, L. D., 32, 39
Duncan, M. R., 132
Durrell, L. W., 88

Eichmeier, A. H., 177
Ellis, B. G., 167
Eslick, R. F., 225
Evans, N. A., 19

Farris, D. E., 214
Farshtchi, D., 218
Ferber, A. E., 128
Ferguson, D. E., 257
Flannery, R. D., 50
Fleming, G. A., 62
Fletcher, H. F., 100
Fooks, J. H., 288
Ford, Z. T., 142, 220
Fortson, J. C., 237
Fouss, J. L., 33
Fox, R. H., 87
Fox, R. L., 69
Francki, R. I. B., 105
Francois, L. E., 96
Frans, R. E., 226
Franzini, J. B., 46
Freeman, J. F., 268
Frost, K. R., 26
Fry, B. O., 210
Fuehring, H. C., 99
Fukuda, H., 36
Fuller, W. H., 87

Gain, E. W., 31
Gallagher, P. A., 73
Ganje, T. J., 77
Gardner, J. L., 12
Garton, J. E., 24
Gentry, C. R., 230
George, E. J., 169
Gilles, K. A., 295

Glowail, S. I., 173
 Godbey, E. G., 186
 Godfey, C. L., 117
 Goss, W. K., 239
 Graham, T. W., 142
 Green, V. E., Jr., 191
 Grigor'yev, G. I., 118
 Gudauskas, R. T., 231
 Gupta, U. C., 80
 Gustafson, P. F., 282

 Haas, H. J., 75
 Haghiri, F., 274
 Haines, C. E., 191
 Hanks, R. J., 52
 Hannapel, R. J., 87
 Hanson, A. A., 269
 Hantush, M. S., 22
 Harding, R. B., 94
 Harper, J. A., 250
 Harper, W. J., 289
 Harris, C. I., 270
 Harris, W. S., 37
 Harrison, D. J., 27
 Harrold, L., 6
 Hassan, N. A., 46
 Hauser, V. L., 143
 Hawes, D., 148
 Hayden, A. J., 233
 Hayden, R. A., 211
 Hayslip, N. C., 109
 Heald, W. R., 43
 Heiberg, S. O., 147
 Hendrickson, R., 273
 Hendrix, A. T., 235
 Hepting, G. H., 181
 Herlihy, M., 73
 Hermann, R. K., 202
 Hershfied, D. M., 21
 Heyne, E. G., 221
 Hickey, W. C., Jr., 134
 Hield, H. Z., 213
 Hill, J. S., 212
 Hobbs, J. A., 221
 Hodges, E. M., 187
 Hodgson, J. M., 225
 Hole, F. D., 119
 Holifield, E. L., 226
 Holmes, R. G., 33
 Hopkins, H. E., 199
 Hubbell, D. W., 17
 Hughes, C., 216
 Hyde, R. B., 110
 Hylton, L. O., Jr., 91

 Igaravidez, L., 209
 Iritani, W. M., 298

 Jackson, R. D., 49
 Jackson, R. M., 86
 Jackson, W. A., 61, 67
 James, J. W., 178
 Joham, H. E., 97
 John, K. R., 246
 Johnson, D. R., 256
 Johnson, F. M., 258
 Johnson, H. P., 29
 Johnson, L. C., 138
 Johnson, N. E., 201
 Johnson, R. E., 61
 Johnson, R. R., 274
 Johnson, V. E., 123
 Johnson, W. H., 140
 Jones, B. A., 138
 Jones, M. B., 108
 Jones, R. E., 215
 Jones, R. L., 116
 Jordan, R. M., 189
 Juska, F. V., 269

 Kaddah, M. T., 173
 Kahn, B., 287
 Kastelic, J., 290
 Kawaguchi, K., 54
 Keller, T., 104
 Kelly, O. D., 74
 Kemper, W. D., 48, 56
 Kennedy, R. A., 114
 Kesterson, J. W., 273
 Kidder, E. H., 177
 Kidder, R. W., 95, 191,
 240, 241
 Kincaid, D. R., 12
 Kindingstad, E., 15
 Kirk, W. G., 190
 Kirkham, D., 14, 29, 47,
 50
 Klawitter, R. A., 258
 Klement, A. W., Jr., 277,
 284
 Klimstra, W. D., 243
 Knake, E. L., 227
 Knoll, H. A., 180
 Knuder, H. M., 130
 Koch, W., 104
 Koelzer, V. A., 41
 Koger, M., 240
 Kohl, R. A., 44
 Kondner, R. L., 18

 Konovalova, A. S., 118
 Kottman, R. M., 2, 276
 Krantz, B. A., 71
 Krauss, W. E., 275
 Krausz, N. G. P., 245
 Kretschmer, A. E., Jr.,
 109
 Krohn, J. A., 123
 Kroontje, W., 76
 Kubota, J., 93
 Kuhlman, A. R., 13
 Kunze, R. J., 47
 Kurtz, L. T., 100
 Kyuma, K., 54

 Langille, W. M., 106
 Lathwell, D. J., 107, 180
 Lang, E. P., 283
 Lawson, F. R., 230
 Lawton, K., 167
 Leaf, A. L., 147
 Leggett, G. E., 89
 Leiser, A. T., 149
 Lemon, L. G., 245
 Lewis, J. K., 13
 Ligon, J. T., 29
 Lilis, R., 223
 Longenecker, D. E., 170
 López-Rosa, J. H., 209
 Lovely, W. G., 228
 Luker, C., 122
 Luthin, J., 38
 Lyerly, P. J., 170
 Kykov, A. M., 139
 Lyle, J. A., 231

 Maasland, D. E. L., 48,
 56
 McArthur, W. C., 237
 McCaleb, J. E., 187
 McCracken, R. J., 67
 McCreery, R. A., 83, 102
 Mack, K. B., 146
 MacKay, D. C., 106
 MacKenzie, A. J., 53
 McManus, B. R., 222
 McNeal, X., 195
 Madgwick, H. A. I., 147
 Malo, B. A., 78
 Mannerling, J. V., 138
 Marten, G. C., 189
 Martin, P. E., 71
 Martin, W. E., 239
 Meade, J. H., 240

Mederski, H. J., 5
 Meek, B. D., 53
 Mehrotra, N. K., 174
 Merz, R. W., 260
 Meyer, L. C., 138
 Mickelson, R. H., 169, 172
 Miller, M. P., 94
 Miller, R. K., 207
 Miller, R. S., 254
 Miller, W. J., 102, 235
 Moolani, M. K., 227
 Morrison, J. W., 110
 Mortensen, J. L., 293
 Motiramani, D. P., 64
 Mullin, R. E., 79
 Myers, W. M., 297

 Nelson, L. E., 70
 Neuberger, J. W., 13, 176
 Newman, J. C., 137
 Norman, A. G., 294
 Nussbaumer, R., 102

 Odell, R. T., 111
 Ogle, W. L., 146
 Ogrosky, H. O., 42
 Olson, R. A., 69
 Oring, L. W., 264
 Owens, G. P., 244

 Page, A. L., 59, 77
 Palmer, A. Z., 241
 Pande, H. K., 144
 Patel, N. G., 271
 Patrick, H., 280
 Patrick, W. H., Jr., 60
 Patterson, R. P., 101
 Peacock, F. M., 187, 190
 Pearson, R. W., 92
 Peele, T. C., 186
 Perkins, H. F., 102
 Phillips, S. A., 28
 Phillips, W. M., 141
 Place, G. A., 296
 Porter, L. K., 48, 75
 Purvis, E. R., 78

 Rasmussen, D. C., 297
 Read, R. A., 208
 Rector, C. W., 175
 Reeve, R. C., 171
 Reid, P. H., 98

 Rhoades, E. D., 194
 Rhoades, H. F., 69
 Rich, C. I., 66
 Rios, M. A., 92
 Rivera, J., 281
 Rodgers, J. P., 261
 Roseberry, J. L., 243, 248
 Rosell, R. A., 90
 Rosenberg, N. J., 182
 Ross, G. J., 167
 Rzhanitsyn, N. A., 9

 Sale, P. J. M., 27
 Sanborn, J. M., 149
 Sandoval, F. M., 169, 172
 Saunders, F. B., 237
 Savage, E. F., 211
 Sawhney, B. L., 58
 Sayre, W. W., 17
 Schimming, B. B., 18
 Schmid, P., 38
 Schnitzer, M., 80
 Schreiber, H. A., 12
 Schreven, D. A., Van, 81
 Schuster, J. L., 192
 Schwab, G. O., 4, 33
 Shambaugh, G., 4
 Sharp, A. L., 13, 176
 Shaw, M. D., 271
 Shaw, L. H., 183
 Shaw, R. H., 179
 Shields, L. M., 88
 Shirley, R. L., 190
 Shull, H., 35
 Simmons, W. P., 16
 Sims, J. R., 59
 Singh-Dhaliwal, T., 209
 Sinha, B. K., 174
 Sleeman, J. R., 112
 Slife, F. W., 227
 Smith, F. W., 221
 Smith, L. H., 297
 Smith, R. M., 120, 121
 Snustad, N., 129
 Snyder, F. F., 40
 Soderberg, A. D., 23
 Soileau, J. M., 67
 Soofi, G. S., 99
 Sparks, W. C., 298
 Spooner, A. E., 188
 Sprague, M. A., 185
 Stamey, W. L., 120, 121
 Staniforth, D. W., 228
 Stanley, J. M., 230
 Steiner, G., 209

 Stevenson, F. J., 85
 Stewart, B. A., 75
 Stickler, F. C., 221
 Stockinger, K. R., 53, 171
 Stockler, F. D., 242
 Stockwell, H. J., 19
 Straub, C. P., 285, 288
 Stubbs, J., 258
 Suman, R. F., 186
 Swartzendruber, D., 34

 Talbert, R. E., 234
 Tanaka, A., 223
 Taylor, H. M., 143
 Taylor, S. A., 44
 Thomas, G. W., 57, 68
 Thompson, J. C., Jr., 278
 Thornton, R. B., 149
 Thrasher, F. P., 225
 Todd, F. A., 279
 Torres-Sepulveda, A., 209
 Triplett, G. B., Jr., 140
 Troll, J., 148
 Tugwell, N. P., 217
 Tvedten, H. A., 129

 Ulrich, A., 90, 91

 Vaartaja, O., 205
 Vamos, R., 72
 Vandoren, D. M., Jr., 140
 Vaught, R. W., 262
 Vergara, B. S., 223
 Vlamis, J., 103
 Vogl, R. J., 259
 Volk, G., 1

 Waddington, D. V., 148
 Waddle, B. A., 217, 219
 Waite, P. J., 179
 Walker, C. R., 241
 Wang, F. C., 46
 Ward, A. L., 253
 Ward, W. E., 211
 Warren, G. F., 270
 Washichek, J. N., 19
 Weimer, E. R., 125
 Wedin, W. F., 189
 Weller, M. W., 263
 Wells, H. D., 267
 Wheaton, R. Z., 177
 White, D. P., 8

White, M., 222
Whitenberg, D. C., 97
Wiklander, L., 295
Wilde, S. A., 196, 198
Williams, D. E., 91, 103
Wilson, E., 4
Winger, R. J., Jr., 39
Winjum, J. K., 201
Wise, J. O., 236, 238

Wollum, A. G., II, 84
Woodruff, N. P., 124
Woods, S. G., 186
Woodworth, R. C., 236
Wooldridge, D. D., 135
Wyatt, R., 60

Yates, W. E., 168
Yegorov, V. Y., 139
Yermanos, D. M., 96
Yesilsoy, M. S., 115
York, J. O., 195
Youngberg, C. T., 84
Youngquist, C. V., 3
Younts, S. E., 101
Yung, F. D., 272

Zaslavsky, D., 14, 45

